Hydrogeology of Ontario
Series (Report 2)

AN ASSESSMENT OF THE GROUNDWATER RESOURCES OF NORTHERN ONTARIO

AREAS DRAINING INTO HUDSON BAY, JAMES BAY AND UPPER OTTAWA RIVER

BY

S. N. SINGER AND C. K. CHENG

ENVIRONMENTAL MONITORING AND REPORTING BRANCH

MINISTRY OF THE ENVIRONMENT

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PREFACE

This report provides a regional assessment of the groundwater resources of areas draining into Hudson Bay, James Bay, and the Upper Ottawa River in northern Ontario in terms of the geologic conditions under which the groundwater flow systems operate. A hydrologic budget approach was used to assess precipitation, streamflow, baseflow, and potential and actual evapotranspiration in seven major basins in the study area on a monthly, annual and long-term basis. The report is intended to provide basic information that can be used for the wise management of the groundwater resources in the study area.

Toronto, July 2002.

DISCLAIMER

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1. EXECUTIVE SUMMARY

This report describes, on a regional scale, the occurrence, quantity and quality of groundwater in areas draining into Hudson Bay, James Bay and the Upper Ottawa River in northern Ontario. It uses a mass balance approach to calculate the monthly, annual and long-term components of the water budgets for seven major basins within the study area.

The report used data obtained from the Water Well Information System (WWIS) of the Ontario Ministry of Environment (MOE). ArcView, a geographic information system, was used in the study with the WWIS database to produce hydrologic maps and geologic cross-sections.

The geologic maps of northern Ontario produced by the Ministry of Northern Development and Mines at a scale of 1:1,000,000 were used to delineate the bedrock and Quaternary geology of the study area. Information such as surface drainage and highways were obtained from digitized maps produced by the Federal Department of Energy, Mines and Resources.

Data related to temperature, precipitation, and surface runoff were used to calculate snowmelt, potential and actual evapotranspiration, and baseflow on a monthly and annual basis as part of the water budget calculations.

Calculations of snowmelt amounts were made by applying the Degree-Day method, calculations of potential evapotranspiration were made by applying the Thornthwaite method, and calculations of actual evapotranspiration were made by applying the Moisture Budget Technique method.

A streamflow separation program was used to assess the long-term groundwater discharge on a monthly and annual basis for eleven small catchments within the study area. Further, statistical techniques were used to define the specific capacity distributions for the bedrock and overburden wells, and flow duration analyses were conducted to assess the variability of streamflows and the drainage characteristics of various basins.

The study area is underlain by the rocks of the Canadian Shield of Precambrian age that form a basement on which younger, flat-lying sedimentary rocks of Paleozoic and Mesozoic age rest. The sedimentary rocks, which are found within the Hudson Bay Lowland and the Upper Ottawa River basin, were deposited during periodic inundation of the early North American continent by inland seas. Recent deposits of the Quaternary epoch form a thin but widespread veneer of gravel, sand, silt, clay, till, and organic

materials covering the older rocks. The Quaternary veneer (*the overburden*) is the product of multiple episodes of glaciation during the last 1.8 million years of Earth history.

Groundwater in the study area is a major source of water supply for a variety of purposes, and it is also critical for the survival of fish and aquatic life in the area's watercourses. A total of 14,703 records for wells constructed in the study area after 1945 is on file with the MOE. Most of these wells are used for domestic and municipal water supply, livestock watering, and commercial and industrial operations.

Bedrock in the study area is an important source of water supply. This is specifically true in areas where the overburden is absent or where the thickness of the overburden is small. Precambrian rocks of the Canadian Shield and the Paleozoic rocks within the Upper Ottawa River basin are the most important bedrock hydrogeologic units in the study area.

Two groundwater systems have been identified within the Precambrian rocks. The first is a shallow system of fresh water that has been explored to a depth of 150 m, and the second is a deep system of brine water that extends hundreds of meters in depth. Significant movement of groundwater in the shallow bedrock is entirely dependent on secondary permeability created by fractures. The intensity and distribution of these fractures play a major role in determining the total porosity, hydraulic conductivity, water yield capability, and infiltration rate of the Precambrian rocks. The groundwater flow regimes within the overburden and the Precambrian rocks are likely hydraulically connected in areas covered with an overburden mantle.

The records of 10,022 wells completed in the Precambrian rocks were examined. Of these, a total of 717 wells has been reported as dry. In all the productive wells, water was found at depths of 280.4 m or less. Approximately 90% of the wells, however, obtain water at depths of 67.1 m or less. The geometric mean of the specific capacity distribution for these wells is 1.9 liters per minute per meter of drawdown (L/min/m).

The majority of wells that obtain water from Paleozoic rocks are in the Upper Ottawa River basin. A few wells tap water from Paleozoic and Mesozoic rocks in the remaining parts of the study area and most of them are test holes drilled by the MOE and Canada Department of the Environment.

The Paleozoic and Mesozoic formations within the Hudson Bay Lowlands that are at or close to the surface contain limestones, dolomites, sandstone, and siltstones can act as good aquifers. Poor water quality in these deposits, however, may prove to be a major impediment.

A total of 1,912 wells has been identified in the Paleozoic rocks within the Upper Ottawa River basin. Of these wells, 68 have been reported to be dry. Water was found in 90% of the wells at depths of 65.5 m or less. The geometric mean of the specific capacity distribution for these wells is 3.5 L/min/m. The wells are in the Beekmantown Group (Lower Ordovician), Ottawa Group (Middle and Upper Ordovician), Liskeard Group (Middle and Upper Ordovician), Wabi Group (Lower and Middle Silurian), and Earlton and Thornloe Formations (Middle Silurian).

Overburden in the study area is also a major source of water supplies. Deposits of sands and gravel of glaciofluvial, glaciolacustrine, glaciomarine, and recent origins are widespread within the overburden covering an area of about 51,300 km^2. This is about half the size of southern Ontario. These sands and gravels, especially when they are large in areal extent and thickness, act as important aquifers.

The total number of wells in the overburden area is 2,737 and most of these wells are within the Upper Ottawa and Moose River basins. A total of 309 wells has been reported as dry. Approximately 90% of the productive wells obtain water at depths of 50.3 m or less.The geometric mean of the specific capacity distribution for these wells is 5.1 L/min/m.

The water budget provides a summary of the hydrologic cycle within a basin. The calculations associated with the assessment of a water budget consider the amount of precipitation that falls on the basin, the amount of water that is returned back to the atmosphere through actual evapotranspiration, the amount of water that becomes surface runoff, and, when possible, the changes in soil moisture storage and groundwater storage. As part of this report, the water budgets for the Severn, Winisk, Attawapiskat, Albany, Moose, Montreal, and Petawawa River basins have been calculated.

The climate of the study area is primarily continental with cold winters and mild summers and it exhibits seasonal and local variations. Extreme weather events such as prolonged periods of extreme cold are common. The minimum monthly temperatures occur mainly during November to April, and the maximum monthly temperatures occur mainly during May to August.

Most precipitation falls as showers and thunderstorms during the period June to September and as snow during the period October to May. Annual precipitation amounts increase from northwest to southeast - a reflection of the increasing influence of moisture transported from the Great Lakes and the Gulf of Mexico. Precipitation during almost half of the year is locked in a snowpack. As a result, the amount of available liquid water within the study area on annual basis could in some years be less than the precipitation input and in others more. Further, liquid water during almost half of the year is not available to recharge

groundwater or as a surface runoff, and streamflow during this period is sustained mainly by surface storage in various lakes and by groundwater discharge as baseflow.

The combined amount of rainfall and snowmelt within the study area is almost nil from November to March, and it is far less than the precipitation input. On the other hand, during March, April and frequently May the sum of rainfall and snowmelt is much larger than the precipitation input. The large volume of water that is released during this period generates high flows and sometimes floods and contributes substantially to groundwater storage through infiltration. It is possible to state, therefore, that the major period of groundwater recharge within the study area coincides closely with the snowmelt period.

Evapotranspiration is the combined evaporation from water, snow and soil surfaces and transpiration by vegetation. When the supply of water is non limiting, evapotranspiration occurs at the potential rate. If the water supply is limited, on the other hand, actual evapotranspiration will fall short of potential evapotranspiration. Actual evapotranspiration within the study area is almost nil from November to May, and it becomes substantial during the period June to October. Highest evapotranspiration values, however, occur during the months of June, July, and August.

Highest river flows in the study area occur during the snowmelt season in May and June and sometimes in April. Unlike the river flows in southern Ontario, however, where the lowest flows occur during the summer and fall seasons, the lowest flows in the study area occur mainly in the months of January, February, March, and April. This is because precipitation during this period occurs as snow which becomes locked in a snowpack inhibiting surface runoff.

Streamflows measured in eleven small watersheds within the study area were separated into direct runoff and baseflow. The separation results indicate that groundwater contributions to streamflow vary on a daily, monthly, annual, and long-term basis. These variations reflect differences in geologic and climatic conditions. The smallest groundwater contributions occur from November to March and the largest occur from May to July.

Groundwater is a resource that is being replenished annually through the process of recharge. Most of the recharge occurs in areas where sand and gravel deposits outcrop at the surface. Factors affecting the recharge process include the status of moisture within the soil, the topographic characteristics of the area, the vertical permeability of the overburden deposits, and the intensity and distribution of the fracture system in the bedrock.

Groundwater recharge proceeds at a maximum rate when the soil is in a state of complete saturation and diminishes when the soil is at the dry limit. In northern Ontario, this condition is met mainly during the snowmelt period and rainfall events from May through June and early July. During the summer and early fall, the soil moisture is utilized mainly by plants through evapotranspiration and a state of soil moisture deficiency usually prevails. Therefore, most of the infiltrated water from the rain, during this period, is used to satisfy this soil moisture deficiency with little or no water is left to recharge groundwater. Precipitation during the period from November to April is mainly in the form of snow and it is not available for groundwater recharge.

The long-term mean annual groundwater recharge is approximately equal to the long-term mean annual discharge. This is because the sum of changes in groundwater storage approaches zero over an extended period of time. The following ranges were determined for the long-term means of annual groundwater recharge in six major basins within the study area:

Severn River basin	27.6 - 37.2 mm
Winisk River basin	30.5 - 42.3 mm
Attawapiskat River basin	30.3 - 40.0 mm
Albany River basin	43.7 - 54.8 mm
Moose River basin	45.5 - 57.9 mm
Upper Ottawa River basin	68.1 - 82.8 mm

The long-term mean annual groundwater recharge for the study area was estimated to range from 33.6 - 44.0 mm which is equivalent to about 57.0 - 75.0 million cubic meters per day.

Chemical analyses for 237 water samples, collected from wells completed in various bedrock and overburden units, were used to evaluate the natural groundwater quality within the study area. The quality parameters considered were sodium, potassium, calcium, magnesium, manganese, iron, carbonate, chloride, nitrate, sulphate, and hardness.

Overall water obtained from bedrock wells show high levels of hardness with values frequently exceeding 250.0 mg/L. Problems with iron and manganese in the bedrock wells are widespread and the use of water treatment devices is common. Further, in isolated areas, metals such as arsenic, cadmium, nickle, lead, copper, and zinc can present problems. Water samples collected from wells completed in the overburden also show high levels of hardness, chloride, sulphate, and iron.

To characterize the susceptibility of groundwater to contamination within the study area, six hydrogeologic environments have been identified. The Canadian Shield and those areas where sands and gravels outcrop at the surface are two environments that are highly susceptible to contamination. The susceptibility of groundwater to contamination in areas where sand and silty sand till outcrop at the surface can be described as variable. Groundwater has low susceptibility to contamination in areas where deposits of silty clay till or clay are at the surface. Paleozoic rocks within the Hudson Bay Lowlands are protected from contamination by the clay and silt deposits left by the Tyrrell Sea and by the veneer of recent deposits of peat, muck, and marl. On the other hand, the Paleozoic rocks within the Upper Ottawa River basin are not protected. Groundwater in these rocks has generally a high susceptibility to contamination.

The main potential threats that may cause groundwater contamination in the study area are the salt drainage associated with highway deicing operations, faulty septic systems, and fuel leaks from underground storage tanks. Many resource-based industries are found within the study area. Effluent from the waste treatment and coal and ash storage facilities associated with these industries may pose localized threats to groundwater. Agricultural activities within the study area are small. Therefore, it is expected that pesticide and nitrate related problems are minimal.

2. INTRODUCTION

2.1 LOCATION OF THE STUDY AREA

The study area is in northern Ontario and it lies between Latitudes 45^o 21' and 55^o 59' N, and between Longitudes 76^o 22' and 95^o 9' W. It is bounded on the north by Hudson Bay, on the east by James Bay and the Ottawa River, on the south and southwest by the Great Lakes basin, and on the west and northwest by the Province of Manitoba (Figure 1). It has an area of about 618,125 km^2, a length of about 1,600 km in a southeast-northwest direction and a width that varies between 20 and 800 km in a southwest-northeast direction.

The study area includes the District of Cochrane and portions of the districts of Kenora, Thunder Bay, Sudbury, Timiskaming, Nipissing, and Renfrew. Railways remain the major transportation routes in the area. The main roads are Highways 11 and 17, and access to settlements in the rest of the study area depends largely on airways.

2.2 IMPORTANCE OF SCALE IN HYDROGEOLOGIC STUDIES

The scale of a hydrogeologic study determines the type and amount of data required, the techniques used, the accuracy of the maps produced, and most importantly the cost of the study. As Struckmeier and Margat (1995) suggested, in thematic cartography the expression small (regional), medium (watershed) or large scale (sub-watershed, a site) is arbitrary and depends on the size of the country. In Ontario, a hydrogeologic study is conducted at a scale between 1:5,000 and 1:10,000 to solve problems in a small local area. Examples include provision of water supplies to new sub-divisions, selection of a landfill site, decommissioning of a contaminated site, or extraction of sand and gravel. The size of the area of interest is measured in a few hectares. The study is usually intensive and the data have to be highly accurate. It may involve the production of an accurate topographic map, drilling of many wells, detailed analyses of geologic logs, pumping tests, and water quality assessment.

Hydrogeologic studies on a sub-watershed scale of 1:10,000 to 1:25,000 usually focus on the specific details that a watershed study does not allow for. The size of the area of interest ranges from 10 to100 km^2. The study may involve spot streamflow measurements, construction of cumulative stream discharge graphs, use of piezometers, continuous measurements of runoff events, water level measurements in wells, pumping tests, and groundwater modelling.

In a hydrogeologic study on a watershed scale of 1:50,000 to 1:100,000, the objective is to describe the groundwater resources in the watershed. The watershed size usually ranges from 100 to 1,500 km^2. The study may include the compilation, analysis and interpretation of existing watershed physical data and geologic information. It also includes the identification of major aquifers and their water-yielding capabilities. The quantification of groundwater recharge and discharge, a water budget analysis, and the evaluation of groundwater quality may also be included.

A hydrogeologic study on a regional scale of 1:500,000 to 1:1,000,000 is usually conducted for an area about 5,000 km^2 in size or more. The objective is to provide a general overview of the significant elements of the groundwater regime within the area. The study usually provides a general overview of the area's physical characteristics and identifies its major geologic units and their water-yielding capabilities. The study may describe the groundwater flow regimes, long-term groundwater discharge and recharge, and general groundwater quality. Such a study is intended to provide basic background information that can be used later in conducting hydrogeologic studies of more detailed scales.

2.3 PURPOSE AND SCOPE OF THE STUDY

The purpose of this report is to assess, on *a regional scale*, the occurrence, quantity and quality of the groundwater resources in the study area, including:

- the compilation, analysis and interpretation of existing information related to physiography, geology, topography, drainage and climate,
- the identification of potential aquifers,
- the calculation of water budgets for seven major basins in the study area including the assessment of each basin's monthly, annual and long-term temperature, precipitation, snowmelt, potential evapotranspiration, actual evapotranspiration, and streamflow,
- the evaluation of the long-term means of annual groundwater recharge and discharge for the selected basins,
- an assessment of the groundwater quality.

2.4 THE SIGNIFICANCE OF THE GROUNDWATER RESOURCES

Groundwater is a valuable resource, which is of great significance to the public health and economic well-being of all the people within the study area. Where available in sufficient quantity, groundwater offers substantial advantages over surface water supplies, including:

- minimum treatment requirements,
- avoidance of long, costly pipelines for municipal supplies,
- uniform temperature and water quality,
- dependable water supply.

Within the study area, groundwater is a major source of water supply for domestic and municipal purposes, livestock watering, and commercial and industrial operations. It is also critical for the survival of fish and aquatic life in the area's watercourses.

To date, no reliable estimates are available for the total amount of groundwater used within the study area or the number of wells constructed before 1945. A total of 14,703 records for wells constructed after 1945, however, is on file with the MOE. The wells are being used as follows:

Number of Wells	**Use**
11,018	Domestic
1,447	Livestock watering
270	Non-municipal public supply
118	Industrial
104	Municipal
1,746	Other uses or unknown

One of the most important attributes of groundwater, which is often overlooked, is its perennial contribution to surface water throughout the year. Groundwater perennial contribution to streamflow is significant for the survival of fish and aquatic life in the watercourses of the study area and it is essential for the preservation of the area's cold water fisheries. The waste assimilative capacity of individual river systems within the study area during drought periods is entirely dependant on groundwater contribution to river flow.

2.5 PREVIOUS INVESTIGATIONS

Over the last 100 years, many geologists and researchers made valuable contributions to enhance the knowledge and understanding of Ontario's physiography and geology. These contributions as bulletins, scientific papers, theses, reports and maps continue to provide invaluable background information to practitioners in the field of applied hydrogeology.

It should be noted that early climatic studies in Ontario were concerned with the establishment of a meteorological network, instrumentation, and data analyses.

Temperature normals for Ontario were prepared in 1964 and precipitation normals were prepared in1965 by the Climatological Research Division. Sporns (1963) prepared a rainfall intensity-duration-frequency maps for Ontario, and Burrows (1964) examined the differences in temperature data from ordinary climatological stations arising from once daily readings as compared to twice daily readings.

Scientific interest in acid precipitation, climate change and droughts started in the mid-eighties and it continues to date. Smit (1987) evaluated the implication of climatic change for agriculture in Ontario. Allsopp and Cohen (1986) described the potential impacts of the carbon dioxide induced climate change on the Province of Ontario, and Bishop (1989) evaluated the effects of climate change on Ontario's water quality.

Bostock (1970) described the physiography of Canada and identified major physiographic regions in Ontario. Chapman and Putnam (1984), in their classic publication entitled: "The Physiography of Southern Ontario", provided an overview of the glacial history of southern Ontario which is important to understanding the glacial geology of the study area.

The North American Plate was initially subdivided into tectonic provinces by Gill (1948) based on variations in structural trends, and later by Wilson (1949) who added lithologic and isotopic age criteria. Streckeisen (1976) proposed nomenclature for plutonic rocks, Jensen (1976) proposed nomenclature and geochemical classification for volcanic rocks, and Winkler (1976) proposed grade terminology for metamorphic rocks. Card and Cielsielski (1986) described the subdivisions of the Superior Province of the Canadian Shield.

A number of geologists made considerable contributions to enhance our understanding of the Paleozoic and Mesozoic strata within the study area. Hume (1925), Bolton and Copeland (1972), and Russell (1984) described the Paleozoic geology of the Lake Timiskaming area. The geology, stratigraphy and structure of the Hudson Platform were described by Sanford, Norris and Bostock (1968), Sanford and Norris (1973 and 1975), Cumming (1975), Norris (1977), Sanford (1987), Sanford and Grant (1990), and Telford (1982, 1988).

A large number of geologists contributed to enhance our understanding of the Quaternary geology of North America and Ontario in general and of the study area in particular. Colman (1941) described the history of the Pleistocene in North America. Flint (1943) described the growth of the North American ice sheet during the Wisconsinan age. Also, Prest (1970) described the Quaternary geology of Canada, Fulton (1984a) described the Quaternary stratigraphy of Canada, and Fulton and Prest (1987) described the Laurentide Ice Sheet and its significance.

Lee (1960) described the late glacial sea episode in the Hudson Bay Lowlands, and McDonald (1969) and Dredge and Nielsen (1985) described the glacial and interglacial stratigraphy of the Lowlands. Further, Skinner (1973) described the Quaternary stratigraphy of the Moose River Basin. In addition, Fullerton (1980) gave a preliminary correlation of events which occurred 16,000 -10,000 years ago in the central and eastern Great Lakes region and the Hudson, Champlain, and St. Lawrence Lowlands. Andrews et al. (1983) described the multiple deglaciation history of the Hudson Bay Lowlands since the deposition of the Missinaibi Formation, and Shilts (1984a) described the Quaternary events that occurred there.

Elson (1967) described the geology of glacial Lake Agassiz, and Vincent and Hardy (1979) described the evolution of glacial Lakes Barlow and Ojibway within Quebec and Ontario. Clayton (1983) described the chronology of Lake Agassiz drainage to Lake Superior, Teller et al. (1983) described glacial Lake Agassiz, and Teller and Thorleifson (1983) described the Lake Agassiz-Lake Superior connection. Drexler et al. (1983) provided a correlation of the glacial lakes in the Superior basin with eastward discharge events from glacial Lake Agassiz, and Fenton et al. (1983) described the Quaternary stratigraphy and history in the southern part of Lake Agassiz basin. Vincent and Hardy (1979) described the evolution of glacial Lakes Barlow and Ojibway within Quebec and Ontario.

A number of specific investigations were conducted in different parts of the study area. Terasmae and Hughes (1960a) conducted a geological study of Pleistocene deposits in the James Bay Lowlands, and Terasmae and Hughes (1960b) described the glacial retreat in the North Bay area. Hughes (1965) described the surficial geology of part of the Cochrane District, Boissoneau (1966, 1967) described the glacial history of the Cochrane-Hearst and the Timiskaming-Algoma areas, and Harrison (1970) described the deglaciation and proglacial drainage in North Bay-Mattawa area. In addition, Anderson (1988) described pollen of Late Quaternary in the Ottawa Valley-Lake Ontario region and its application in dating the Champlain Sea, and Barnett (1988) described the history of the northwestern arm of the Champlain Sea.

Field reconnaissance work was also conducted within the study area. Baker et al. (1984) conducted a till sampling program in the Matheson area, District of Cochrane, and Steele et al. (1986) conducted a reconnaissance till sampling program in the Matheson-Lake Abitibi area, District of Cochrane.

In 1992, the Ontario Geological Survey and the Ministry of Northern Development and Mines published a comprehensive volume entitled: "The Geology of Ontario, Special Volume 4". The volume consists of 1,430 pages of text, and 41 sheets of maps and charts. This unique volume (Thurston et al.1991) presents a synthesis of the massive information

and data related to Ontario’s geology that accumulated over the past 100 years. The publication chronologically describes the geological events that extend from crustal formation to present-day ongoing surficial processes.

Two chapters in “The Geology of Ontario, Special Volume 4" by Thurston (1991) describe the Archean Superior Province and the Proterozoic geology. Also, a chapter by Bennett et al. describes the Huronian Supergroup and associated intrusive rocks of the eastern part of the Southern Province, and another chapter by Easton describes the Grenville Province. Chapter 20 of the publication by Johnson et al. provides a review of the Paleozoic and Mesozoic stratigraphy and history of Ontario. It subdivides the record into 10 depositional sequences and defines the stratigraphic intervals of genetically related sedimentary rocks. Also, Barnett in Chapter 21 of the same publication provides a comprehensive description of the Quaternary geology of Ontario and an extensive list of references related to the topic. Among other things, Chapter 21 includes a review of major landforms and glacial deposits, and detailed description of the Quaternary geology and history of glacial lakes.

According to Watt (1952), the first preliminary groundwater survey in Ontario was conducted in 1945. After this survey was completed, it was realized that any future groundwater studies must have accurate drilling records as their basis. The Well Drillers' Act provided the framework for the water well legislation. Under Section 2 of this Act, the Minister of Mines was given the authority to make the necessary regulations regarding the issuance of licences to the well drillers and the requirement to submit well records. Currently, the Minister of Environment has, under the Ontario Water Resources Act, the supervision of water in the province, including the supervision of the water well drilling industry.

Although a great body of knowledge related to Ontario's groundwater resources has been accumulated since 1945, a few relevant studies have been conducted within the study area. Watt (1952) provided the first overview of groundwater in the province. The overview was based on measurements of water levels in observation wells found exclusively in southern Ontario and on information obtained from the available well records.

In 1965 the Governments of Canada and Ontario agreed to undertake a series of coordinated studies of Ontario’s northern water resources and related economic development. Most of the work was undertaken in five large river basins draining to Hudson Bay and James Bay, namely, the Severn, Winisk, Attawapiskat, Albany, and Moose River basins. During the period 1965 to 1973, a hydrometric network, including precipitation, streamflow stations, and snow courses, was established. In addition, a groundwater monitoring network was installed, water quality samples were collected from selected streams, lakes and wells, and biological and sediment samples were collected from

selected lakes. As part of the 1965 Agreement, geologic mapping was undertaken, seismic surveying was carried out and 21 test holes were drilled (Ontario Water Resources Commission 1969, 1970, and 1972, and MOE 1973 and 1975).

The hydrogeology of the Canadian Shield was described briefly by Brown (1970) and the groundwater movement in a glacial complex in the Cochrane area was described by Parsons (1970). Wang and Chin (1978) evaluated the groundwater data obtained under the 1965 Agreement. They presented a brief description of the geography and geology of the Severn, Winisk, Attawapiskat, Albany, and Moose River basins, and provided useful details regarding the distribution, subsurface characteristics, hydraulic properties, and water-yielding capabilities of various geologic formations.

Singer et al. (1997) described the hydrogeology of southern Ontario based on the hydraulic parameters of various bedrock and overburden units, and the geologic conditions under which groundwater flow systems operate. The report provides useful information related to the groundwater quality and the water-yielding capability of the Precambrian rocks of the Canadian Shield.

2.7 ACKNOWLEDGEMENTS

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3. DATA AND METHODS USED IN THE STUDY

3.1 DATA USED IN THE STUDY

This study used data obtained from the well records on file with the MOE and the geologic logs of test holes published by the Ontario Geological Survey. Information such as county boundaries and shorelines were digitized from maps of a scale 1:100,000 produced by the Ontario Ministry of Transportation. Additional information such as surface drainage and highways were obtained from digitized maps produced by the Federal Department of Energy, Mines and Resources. The geologic maps of northern Ontario produced by the Ministry of Northern Development and Mines at a scale of 1:1,000,000 were used to delineate the bedrock and Quaternary geology of the study area.

Precipitation data determine the water input into an area of interest. Temperature data, on the other hand, are indispensable for understanding of the temperature regime of the area, and for the calculation of snowmelt and potential and actual evapotranspiration. Precipitation and temperature data for selected long-term meteorological stations in the study area were obtained from Environment Canada.

Streamflow data are extremely useful in assessing groundwater discharge from a given catchment by using streamflow separation techniques. They are also indispensable part of water budget calculations. Records of streamflow data for selected streamflow gauging stations within the study area were obtained from Environment Canada.

Appendix I gives a list of the meteorologic stations found above Latitude 45^0 N with long-term temperature data. The list contains the station identification number and the name, geographic coordinates, and elevation of the station. Appendix II gives a list of the precipitation stations in northern Ontario. The list is organized by district name, and station number, name, geographic coordinates, and period of records. Appendix III gives a list of the streamflow stations in northern Ontario. The list is organized by station number and name.

In addition, the results of 237 chemical analyses for water samples, collected from wells completed in various bedrock and overburden units, were used to describe the groundwater quality in the study area. The quality parameters considered were sodium, potassium, calcium, magnesium, manganese, iron, carbonate, chloride, nitrate, sulphate, and hardness.

3.2 THE WATER WELL INFORMATION SYSTEM

Water well regulations requiring well records to be submitted to the Ontario Department of Mines came into force early in 1946. The number of records submitted by well drillers annually increased steadily from less than 500 in 1946 to more than 4,000 in 1971. To deal with this increasing number of records, the previous Ontario Water Resources Commission decided in 1972 to initiate the Water Well Information System (WWIS).

The WWIS is a computerized database designed to allow for the easy retrieval of data describing the characteristics of water wells in Ontario (Mantha 1988). As of this date, the WWIS database contains approximately 500,000 well records. Most of the records are for wells constructed between 1946 and 1984.

The well record is a document designed mainly to protect the interest of the well owner should a problem related to poor well construction arise, or should maintenance or repairs become necessary. In addition, the MOE staff use the well records to regulate the well construction industry, and assess the groundwater resources of the province.

Information on up to 212 parameters is found in the well record, including:

- surface elevation,
- location: UTM coordinates, county or district, township, borough, city, town or village, lot, concession, and watershed,
- geology: types of deposits in the well log,
- water: depths at which water was found, depth to static level, and the kind of water found as fresh, salty, sulphurous, or containing iron or gas,
- pumping test and well yield,
- well construction details: casings, screens, plugs, and seals,
- date of well completion,
- names and addresses of well owner and well driller.

A quality control feature, which assigns different quality indices to the coordinates and elevation of the well, is part of the WWIS database. The indices range from one for high quality data to nine for poor quality data. This allows the user to select only those data that have the highest degree of accuracy about well location and elevation.

Since its inception, the WWIS database has been an indispensable tool for the mapping and protection of Ontario's groundwater resources, and no hydrogeologic investigation has been conducted in Ontario without strong reliance on it. It will continue to provide valuable

information on the occurrence, quantity and quality of groundwater to home owners, well contractors, hydrogeologic consultants, academia and various government agencies.

3.3 METHODS USED IN THE STUDY

In the past, the analysis and interpretation of information obtained from the WWIS database for a given area was done manually. This was a time-consuming process because of the great number of records that had to be considered. Recent advances in the field of Geographic Information Systems (GIS) made it feasible to consider a large amount of data, to present these data on thematic maps, and to conduct many analyses and interpretations within a short time. ArcView is such a GIS system and it is suitable for use with the WWIS database.

Overall, GIS systems provide environments for displaying the data and analytical results within the context of local geography. In addition, enhanced statistical techniques are included in some of these systems and advanced modelling can be done. As with other GIS systems, ArcView provides the opportunity to visualize, explore, query, and analyse the water well data geographically. The program can display the results in colours or symbols so that similar regions can be readily identified. This capability is extremely useful in conducting hydrogeologic analyses. For additional functionality, the Spatial Analyst Extension of ArcView is used with the water well data to create contour maps. By using the WWIS database with ArcView many hydrogeologic maps were produced. The maps show well locations, the well types (bedrock or overburden), geology, and specific capacities of bedrock and overburden wells.

In Ontario, a considerable part of precipitation falls in the form of snow in the winter and fall seasons. Therefore, a complete description of the precipitation process for a basin has to include by necessity information on snow measurement, accumulation and melt. The generation of snowmelt at a point in a snowpack is essentially a thermodynamic process, the amount of the snowmelt produced being dependent on the net heat exchange between the snowpack and its environment (Gray 1970**)**. To account for snowmelt in seven major basins within the study area, the Degree-Day method was used. The method uses the daily average temperature and rainfall as the only factors to estimate the daily snowmelt.

Evapotranspiration is the combined evaporation from water, snow and soil surfaces and transpiration by vegetation. When the supply of water is non limiting, evapotranspiration occurs at the potential rate. If the water supply is limited, on the other hand, actual evapotranspiration will fall short of potential evapotranspiration. Estimates of monthly and annual potential evapotranspiration for the seven basins within the study area were made

by applying the method of Thornthwaite (Gray 1970). The method employs an empirical equation which relates the potential evapotranspiration to the mean air temperature and it includes a latitude adjustment factor for various months. This method was selected because of the availability of daily temperature data and the lack of more detailed climatological data that are required by other methods.

Estimates of actual evapotranspiration on a monthly and annual basis for seven basins in the study area were made by applying the Moisture Budget Technique method (Holmes and Robertson 1960). The amounts of monthly liquid water calculated for the various meteorological stations were used as the input to the method.

The shapes of flow-duration curves are determined by geologic and hydrologic characteristics, and they provide indications of the natural water storage capacities in various drainage basins. Further, a curve that is nearly horizontal indicates a more permeable basin with relatively larger groundwater storage capacity. It also shows a greater role for groundwater discharge in sustaining a river's flow (Singer 1981). In this study, flow-duration curves were generated to show flow variability and determine a groundwater index for each of the seven river basins.

For the purpose of this study, a flow separation computer program was applied to separate flow into direct runoff and baseflow. The program is based on a procedure which separates the flow into two components, a surface runoff component consisting of direct runoff and inter-flow, and a baseflow component. The program allows for the processing of a large amount of data in a very short time and ensures consistency in the application. Six parameters are used in the program. The first parameter is to detect the beginning of an event, the second is to determine the event period, the third is to detect the peak flow, the fourth is to determine the value of the groundwater component under the peak, the fifth is to determine the relative event limits, and the sixth is to determine the absolute event limit.

In addition, statistical techniques were used to assess the short-term pumping test data and to define the specific capacity distributions of bedrock and overburden deposits.

4. GEOGRAPHY

4.1 PHYSIOGRAPHY

Physiography describes the major surface features of an area controlled by the underlying rock structures, and it supplies useful information that can be used to assess the hydrogeologic characteristics of the area. Many geological processes, including plutonism, metamorphism, sedimentation, faulting, glaciation, uplifting, erosion, and weathering have shaped the physiography of the study area. Glaciation has been one of the most important processes that profoundly reshaped the surface features of the study area during the Pleistocene (Great Ice Age) and the Holocene (Recent) epochs. A variety of glacial landforms such as drumlins, eskers, kames, and end moraines contribute to the diversity of the relief of the study area.

According to Bostock (1970), geological and physiographic distinctions can be made between two main physiographic regions of Ontario: the uplifted broad dome of the Canadian Shield and the surrounding flatter lowlands termed the Borderlands. The Hudson Bay Lowland and the Canadian Shield are the two major physiographic regions within the study area (Figure 2).

4.1.1 The Hudson Bay Lowland Physiographic Region

The Hudson Bay Lowland is a vast swampy area covered with Quaternary deposits on top of flat-lying Paleozoic and Mesozoic sedimentary rocks. The lowland is divided into northwestern and southeastern regions by the northeast-trending Transcontinental Arch (Thurston et al. 1991).

The poor drainage within the lowland and the slow rate of plant decay, which is caused by the cold climatic conditions in the north, have led to the development of peat across much of the area. The lowland, with elevations mainly between 60 and 120 m above sea level (a.s.l.), borders the Hudson Bay and James Bay on the east and northeast and is surrounded by the Canadian Shield on the west and south.

A distinct topographic feature of the lowland is the Sutton Inlier which consists of southeast-trending ridges of Archean and Proterozoic bedrock. The ridges interrupt the lowland, rising150 to180 m above the surrounding area. A successive, narrow cascade of beaches and bars, which are five to 10 m high and could reach several kilometers in length, extends along the coastal areas.

According to a publication by the Ontario Ministry of Natural Resources (OMNR 1998), the Hudson Bay Lowland is a home for the boreal barrens forest, which makes up to 28% of Ontario's forests. It represents a transition zone between the boreal forest and the subarctic tundra to the north. The forest is characterized by scattered patches of black spruce and tamarack woodlands. Denser patches of white and black spruce, balsam fir, and white birch are found on riverbanks where the drainage is good. The boreal barrens are home for woodland caribou, polar bear, arctic fox, black flies and mosquitos. It is also a nesting home for millions of migratory birds during the summer.

4.1.2 The Canadian Shield Physiographic Region

The Canadian Shield, also called the Precambrian Shield or the Laurentian Plateau, has a gently undulating surface that dips gently to the north and south. It is part of a vast horseshoe shaped area covering eastern and central Canada and a small part of the northern United States. The shield rocks are the roots of ancient mountains that formed through the collision of continents and later eroded to become a low relief area with many elongated lakes and intervening bedrock ridges. Land surface elevation is about 150 m (a.s.l.) in the north and increases to about 450 m (a.s.l.) in the south.

Parts of the Shield are bare rocks, others are covered by thin Podzolic soils that are acidic and unproductive. These soils can maintain the boreal forests found in the Shield, but they lose their nutrients quickly under cultivation. Pockets of good soil, however, have been laid down as the ice sheets of the last ice age melted away.

Bostock (1970) subdivided the shield into the Severn Upland, the Abitibi Upland, and the Laurentian Highlands (Figure 2). The Severn and Abitibi Uplands have a rocky landscape, many lakes, and large areas covered with Quaternary deposits. Some land forms associated with the Quaternary deposits include till plains, moraines, drumlins and sand, silt, and clay plains, and old shore and beach deposits. Part of the Abitibi Upland is the Cobalt plain within the Upper Ottawa River basin. The Cobalt plain is characterized by low hummocky terrain interrupted by ridges that rise 150 to 180 m above the surrounding area.

The southmost part of the study area is part of the Laurentian Highlands extending eastward from Georgian Bay to the Ottawa and St. Lawrence Rivers. Within the study area, the Laurentian Highlands form an elevated region underlain by Precambrian rocks.

Wang and Chin (1978) identified three physiographic subregions within the Canadian Shield physiographic region in the study area, an upland area, a lacustrine plain, and a till plain. The three subregions reflect the main type of material found at the surface. The

upland subregion comprises a rim extending along the boundaries of the study area and is underlain by Precambrian rocks and a very thin mantle of sand till. Most of the land surface lies between 350 and 450 m (a.s.l.), but local ridges may rise to 550 m (a.s.l.). End moraine ridges and eskers are the main topographic features in this subregion.

The lacustrine plain subregion extends as a band to the east and north of the upland subregion stretching from the Ontario-Quebec border to the Ontario-Manitoba border. Land surface elevation in the subregion ranges from 120 to 365 m. Morainic ridges and eskers are the main topographic features in this subregion.

The till plain subregion lies between the lacustrine plain and the Hudson Bay Lowlands. The plain is characterized by a low relief with elevations ranging from 250 m to 300 m (a.s.l.). Kame moraines, eskers, and drumlins are the main topographic features in this subregion (Wang and Chin 1978).

Two kinds of forest are found within the Canadian Shield physiographic region, each with unique characteristics and species, the boreal forest and the Great Lakes-St. Lawrence forest. The boreal forest, which makes up to 48% of Ontario's forest, is found within the Canadian Shield part of the study area. It features coniferous and deciduous trees, including white and black spruce, tamarack, balsam fir, jack pine, white birch, and poplar. Terrain of the forest varies from lowland peat bogs to deep upland fertile soils to bedrock covered with thin layers of soil and moss. The forest is home to a variety of wildlife, including moose, black bear, wolves, otter, beaver, blue jays, and insects (OMNR 1998).

The Great Lakes-St. Lawrence forest contains up to 22% of Ontario's forests and is found mainly within the Upper Ottawa River basin. It is a transitional zone between the southern deciduous forest of eastern North America and the coniferous boreal forest, and it contains a mixture of landscapes and plant and animal species. Coniferous trees such as eastern white pine, red pine, eastern hemlock and white cedar mix with deciduous species such as yellow birch, sugar and red maples, basswood and red oak. The forest is home to white-tailed deer, moose, black bear, wolves, beaver, muskrat, otter, birds, fish, and insects (OMNR 1998).

4.2 DRAINAGE

A drainage basin determines the amount of surface water and the direction of movement it takes, and often the direction of movement that groundwater takes. Approximately 84.5% of the area is drained by six major rivers: the Severn and Winisk Rivers that flow into Hudson Bay, the Attawapiskat, Albany, and Moose Rivers that flow into James Bay,

and the Upper Ottawa River on the Ontario side that is part of the Ottawa River system. The remaining 15.5% of the study area is drained by several smaller rivers such as the Kinushseo, Aquatuk, Shagamu and Nishibi Rivers that flow into Hudson Bay and the Atikameg, Lawashi, Ekwan, Opinnagau and Lkitusaki Rivers that flow into James Bay.

4.2.1 The Severn River Basin

The Severn River rises on the Canadian Shield and, like most of the other rivers which issue from the shield, it is still in a youthful or ungraded state. The Severn drains an area of about 91,540 km^2. Its basin, which has a rectangular shape, has a length of about 600 km, a width of about 200 km, and it can be divided into three major sections, the Upper, Middle, and Lower Severn.

The Upper Severn consists of two main parts. One part incorporates five rivers that drain into Sandy Lake. These include the Cobham River, which drains part of the Province of Manitoba, and the McInnis, Flanagan, Dawson, and Rosebery Rivers. Most of these rivers consist of chains of lakes connected by sections of steeper gradients. Among the lakes in this part of the Severn are McInnes Lake, Deer Lake, Favourable Lake, Angekum Lake, Opasquia Lake, and Finger Lake. The second part of the Upper Severn comprises the Windigo River basin that drains into the Severn just below Sandy Lake. Many lakes are found here, including North Caribou, Eyapamikama, Weagamow, Magis, and Nikip Lakes.

The Middle Severn extends for a distance of 300 km to the confluence with the Fawn River. The major tributaries to Middle Severn are the Makoop River, the Big Trout Lake system, and the Fawn and Sachigo Rivers.

The Lower Severn extends to Port Severn on Hudson Bay for a distance of about 80 km. Its major tributaries are the Beaver and Dicky Rivers. Partridge Island is at the entrance of the Severn to Hudson Bay.

4.2.2 The Winisk River Basin

The Winisk River rises on the Canadian shield and drains an area of about 68,700 km^2. Its basin can be divided into three major sections, the Upper, Middle, and Lower Winisk. The Upper Winisk, which is about 160 km long and 40 to 60 km wide, is drained entirely by the Pipestone River.

At Big Beaver House, the Pipestone River enters complicated systems of lakes that cover a very large area within the headwaters of Middle Winisk. One system of lakes includes the Wunnummin, Chipai, Kanuchuan, and Winisk Lakes. Another system is found within the Asheweig River basin, and includes Maria, Kinghsher, and Shibogama Lakes. The Middle Winisk, which is about 260 km long and 160 to 240 km wide, extends from Big Beaver House to the confluence with the Asheweig River.

The Lower Winisk, which is about 160 km long and 40 to 160 km wide, extends from the confluence with the Asheweig River to Winisk on Hudson Bay. Its main tributaries are the Shamattawa and Mishamattawa Rivers.

4.2.3 The Attawapiskat River Basin

The Attawapiskat River rises on the Canadian shield and drains an area of about 57,485 km^2. The basin can be divided into three major sections, Upper, Middle, and Lower Attawapiskat. The Upper Attawapiskat, which is about 220 km long and 50 to 110 km wide, is drained entirely by the Otoskwin and Pineimuta Rivers. Both rivers, which contain many lakes in their headwaters, empty into Kabanta Lake that, in turn, empties into the Attawapiskat Lake system.

The Middle Attawapiskat, which is about 180 km long and up to 120 km wide, extends from the outlet of Attawapiskat Lake to the confluence with the Missisa River. The main tributary to the Middle Attawapiskat is the Muketei River.

The Lower Attawapiskat, which is about 180 km long and up to 100 km wide, extends from the confluence with Missisa River to James Bay. The Village of Attwapiskat is about 10 km to the west of James Bay. The Missisa River is the main tributary to the Lower Attawapiskat. Akimiski Island is about 20 km east of the point where the Attawapiskat River enters James Bay.

4.2.4 The Albany River Basin

The Albany River basin, which is about 137,230 km^2, is a complicated drainage system that can be divided into three major sections, the Upper, Middle, and Lower Albany. Waters from three areas within the headwaters have been diverted outside the basin. One area, Lake St. Joseph, has been diverted to the Nelson River basin; a second area, Ogoki, has been diverted to Lake Nipigon; and a third area, Long Lake, has been diverted to Lake Superior.

The Upper Albany is about 540 km long and 100 to 300 km wide. It extends from the water divide in the Canadian Shield to the confluence with the Ogoki River. It contains many lakes, including the Cat Lakes system, the St. Joseph Lakes system, and Wabakimi, Whitewater, Mojikit, and Ogoki Lakes.

The Middle Albany extends from Ogoki to the confluence with the Kabinakagami River, its main tributary. Kabinakagami River is a large and complicated drainage basin. Its headwaters extend for about 330 km and include the Kapikotongwa, Nagagami, and Shekak Rivers.

The Lower Albany, which is about 240 km long and 30 to 120 km wide, extends from the confluence with Kenogami River to James Bay. The main tributaries in this section are the Chipie and Stooping Rivers. Albany Island is at the entrance of the river into James Bay.

4.2.5 The Moose River Basin

The Moose River basin, which is about 480 km long and 60 to 450 km wide, has a total drainage area of about 96,800 km^2. A small area in the southeastern corner of the basin is within the Province of Quebec. The basin consists of three main sub-basins, Abitibi River, Mattagami River, and Missinabi River.

The Abitibi River shares its southern water divide on the Canadian Shield with the Upper Ottawa River and part of the headwater area, including part of the Abitibi Lake system, is within the Province of Quebec. Major tributaries to the Abitibi River are the Black, Frederick House, Little Abitibi, and North French Rivers.

The Mattagami River rises on the Canadian shield and flows northward to its confluence with the Moose River some 90 km to the west of James Bay. Its major tributaries are the Groundhog and Kapuskasing Rivers. Many lakes are within the headwaters of the Mattagami River, including Grassy, Mattagami, Rice, Rush, Horwood, and Ivanhoe Lakes.

The Missinaibi River sub-basin also rises on the Canadian Shield and flows northeastward to its confluence with the Mattagami River. Its main tributaries are the Opasatika River that joins the Missinaibi from the south and the Mattawishkwia and Pivabiska Rivers that join the Missinaibi from the north.

The Moose River is formed at Sutcliffe which is located at the confluence of the Mattagami and Missinaibi Rivers. The Moose flows northeastward to James Bay some 100 km downstream. Main tributaries are the French River that flows into the Moose from the

south, and the Cheepash and Kwataboahegan Rivers that join the Moose from the north. Many small islands are within the Moose delta. Moosonee is some 20 km to west of James Bay.

4.2.6 The Upper Ottawa River Basin

In this report, the Upper Ottawa River basin refers to that part of the headwaters of the Ottawa River basin which drains about 27,590 km^2 on the Ontario side. It extends from the Moose River basin in the north to Braeside on the Ottawa River in the southeast. It is also bounded by the Ottawa River on the eastern and northeastern sides and by the Great Lakes basin on the western and southwestern sides. The Upper Ottawa basin is entirely within the Canadian Shield and is drained by several rivers the most prominent of which are the Montreal, Mattawa, Petawawa, and Bonnechére Rivers.

Two parallel branches of the Montreal River rise on the Canadian Shield and flow in a northeasterly direction. The first branch turns around after passing through Mistinikon Lake to flow in a southeasterly direction. It meets the second branch south of Matachewan. Below that point the river takes a fairly straight course in a southeasterly direction and joins the Ottawa River at the lower end of Lake Timiskaming. The Montreal River has two main tributaries that flow in a northeasterly direction. One tributary starts from Lake Makobe and joins the river at Elk Lake, and the second starts from Lady Evelyn Lake and joins the River near Highway 558.

The Mattawa River, which rises just east of North Bay, flows eastward through a depression along the Coulonge Fault. From Lake Talon to Mattawa on the Ottawa River, the river flows within a canyon up to 100 m deep. Its main tributary is the North River, which joins the Mattawa River from the north. Several small tributaries, on the other hand, join the Mattawa River from the south. The largest of these is the Amable du Fond River, which rises at Kawawaymog Lake. It proceeds to drain Waskigomog, Wilkes, and Kioshkokwi Lakes before entering the Mattawa River downstream from Lake Talon.

The Petawawa River rises at Butt Lake on the Canadian Shield and flows in a northeasterly direction to join the Nipissing River at Radiant Lake. From that point the river follows an easterly course until it joins the Ottawa River at Petawawa. Many lakes are found within the headwaters of this river system, including Cedar, Cauchon, and Mink Lakes. One tributary joins the river on the northern side and several join the river on the southern side. Main tributaries are Nipissing, Madawaska, and Barron Rivers.

The Bonnechére River rises in Algonquin Provincial Park and flows about 161 km in a southeasterly direction to join the Ottawa River near Castleford. The course of the river is almost entirely controlled by the bedrock faults in the area. Many lakes are found within the river basin, the largest being Golden Lake, Round Lake and Lake Clear. Main tributaries are the Sherwood River and the Silver Creek.

4.3 CLIMATE

Geology and climate are two critical factors that determine the hydrologic and hydrogeologic characteristics of an area. Geology governs the suitability of certain geologic deposits to act as aquifers, whereas climate controls the availability of water to replenish these aquifers.

The climate of the study area is primarily continental, with cold winters and mild summers and it exhibits seasonal and local variations. Seven long-term meteorological stations were selected to show the variability of climatic conditions within the study area. These stations are:

- Big Trout Lake in the Severn River basin,
- Winisk in the Winisk River basin,
- Lansdowne House in the Attawapiskat River basin,
- Fort Albany in the Albany River basin,
- Moosonee in the Moose River basin,
- New Liskeard in the Montreal River basin,
- Lake Traverse in the Petawawa River basin.

The relatively flat Canadian Shield provides a few barriers to the weather systems sweeping down from the north. As a result, the study area at times experiences a variety of extreme weather events. Extreme low temperatures (-26.1 to - 48.0 ^{0}C) occur mainly during the period November to April, and extreme high temperatures (26.7 to 36.7 ^{0}C) occur mainly during the period May to August (Table 1).

Lakes within the study area become completely ice-covered between November 1 in the north to December 15 in the south. The ice surface in these lakes starts to deteriorate between May 15 in the north to April 1 in the south. Freeze-up of rivers occurs around November 15 in the north and December 15 in the south. Ice breakups occur around May 15 in the north and March 15 in the south (OMNR 1984).

Most precipitation falls as showers and thunderstorms in the summer (June to September) and as snowfall in the winter (October to May). Annual precipitation amounts increase from northwest to southeast - a reflection of the increasing influence of moisture transported from the Great Lakes and the Gulf of Mexico.

The long-term mean annual precipitation and snowfall values are as follows:

Meteorological Station	Precipitation (mm)	Snowfall (mm)
Big Trout Lake	586.8	191.4
Winisk	471.0	118.3
Lansdowne House	666.2	206.9
Fort Albany	539.2	118.5
Moosonee	746.3	234.7
New Liskeard	676.5	212.8
Lake Traverse	796.6	226.7

Evapotranspiration is the combined removal of water to the atmosphere through evaporation from inland water bodies, snow and soil surfaces and through transpiration by plants. Water removed in this way is not available for streamflow or groundwater.

The long-term mean annual potential and actual evapotranspiration are as follows:

Meteorological Station	Potential Evapotranspiration (mm)	Actual Evapotranspiration (mm)
Big Trout Lake	445.0	397.7
Winisk	384.5	368.6
Lansdowne House	470.1	430.1
Fort Albany	447.1	353.7
Moosonee	461.1	431.1
New Liskeard	513.2	417.4
Lake Traverse	539.9	453.9

4.4 POPULATION AND ECONOMY

The natives have lived within the study area for millennia. Development, which occurred during the last three centuries within the study area, is limited to a few centres strung out along transportation routes. Largely, the rest of the study area is empty.

The main population centres within the Upper Ottawa River basin are Cobalt, Deep River, Haileybury, Kirkland Lake, Mattawa, New Liskeard, Pembroke, Petawawa, and Renfrew. Within the Moose River basin, the main population centres are Iroquois Falls, Kapuskasing, Moosonee, Smooth Rock Falls, and Timmins. Within the Albany River basin, the main population centres are Cassock, Cat Lake, Fort Albany, Fort Hope, and Kashechewan. The main population centres within the Attawapiskat River basin are Attawapiskat, Lansdowne House, and Pickle Lake. Within the Winisk River basin, the main population centres are Kasabonika, Kingfisher Lake, Peawanuck, Summer Beaver, and Webequie. The main population centres within the Severn River basin are Angling Lake, Bearskin Lake, Big Trout Lake, Deer Lake, Fort Severn, Muskrat Dam, Sandy Lake, and Weagamow Lake.

Forests and industrial minerals are the backbone of the economy. Over the last three centuries, most industries in Ontario such as trapping, tourism and logging have depended on the forests for their existence. This economic dependance continues today, especially within the study area, where the primary industry of many communities is pulp, paper, lumber and forest-based tourism and recreation.

The mining and exploration sectors of Ontario's economy are responsible for the settlement of many communities within the study area. Some earliest examples of communities built around mining are the settlements of Cobalt, Haileybury, and New Liskeard that arose from the cobalt silver camp that began in the 1880s (Smith 1986). Other settlements with mining-oriented economies include Timmins and Kirkland Lake. Deposits of metals within the study area such as copper, zinc, nickle, silver, and gold are a lucrative business. Lignite deposits and peat bogs of the Hudson Bay Lowland provide an enormous, potential fuel source and fertilizer for horticultural applications (Thurston et al. 1991).

5. GEOLOGY

The occurrence, flow and quality of groundwater are strongly influenced by geology. Therefore, having a full consideration of the characteristics of the geologic deposits within the area under study is important in any groundwater investigation.

5.1 BEDROCK GEOLOGY

The bedrock within the study area is a major source of water supplies to agricultural, commercial and industrial operations, and to municipalities and private home owners. This is especially true in areas where the overburden is absent or where the thickness of the overburden is small.

The bedrock geology of the study area can be subdivided into the older, rugged and erosion resistant rocks of the Canadian Shield of Precambrian age, and the younger, flat-lying sedimentary rocks of Paleozoic and Mesozoic age. Large portions of the bedrock within the study area are covered by a mantle of Quaternary deposits.

5.2 PRECAMBRIAN ROCKS

The most authoritative and detailed compilation of Ontario's geology is the publication of the Ontario Geological Survey entitled:"The Geology of Ontario, Special Volume 4." The publication chronologically describes the geological events over more than three billion years from crustal formation to present-day ongoing surficial processes. Many chapters in the publication deal with various aspects of Precambrian geology in Ontario overall and within the study area in particular. The information contained in the publication was used extensively in this chapter.

Precambrian rocks in North America have been subdivided into the Superior, Southern and Grenville provinces based on differences in age, metamorphism, and tectonic setting (Figure 3). The Superior Province makes up most of the Canadian Shield in Ontario and consists of rocks of Archean age believed to be greater than 2.5 billion years old. Many Proterozoic dikes and plutons have intruded the rocks of this unit.

In Ontario, the Superior Province has been subdivided into subprovinces, commonly fault-bounded, that can be distinguished by contrasting rock type, structural geology, age and metamorphic grade. Overall, the Superior Province consists of the following rocks:

- volcano-plutonic rocks,
- metasedimentary rocks,
- gneissic-plutonic rocks.

It is believed that these rocks are the remains of ancient continents and ocean basins. It is noteworthy that most of Ontario's mineral wealth is associated with these rocks.

Within the study area, volcano-plutonic belts are found within the Sachigo, Uchi, Wabigoon, Abitibi and Wawa subprovinces (Figure 3). These belts are typically of low metamorphic grade in their centres and of a medium metamorphic grade near the margins. They occur as elongate areas of metamorphosed volcanic rocks with minor volumes of metamorphosed sedimentary and granitic rocks.

The metasedimentary rocks, which consist mainly of shale, slate, and sandstone, are predominant in the English River, Opatica, and Quetico subprovinces. In addition, metavolcanic granite and intrusive rocks occur in the English River subprovince, and granite and tonalite rocks occur in the Opatica, and Quetico subprovinces. The metamorphic grade varies from low at the margins of these subprovinces to medium grade and high in their interiors.

Gneissic-plutonic rocks occur in the Berens River subprovince. They consist mainly of tonalitic gneiss and granitoid plutons with minor volumes of high grade, metavolcanic and metasedimentary rocks. An area, found between Wawa and Abitibi subprovinces, is known as the Kapuskasing Structural Zone. It consists of metavolcanic and metasedimentary rocks and tonalitic gneisses, all cut by undeformed granitic units.

The Southern Province consists of rocks of Proterozoic age believed to be 600 to 2.5 billion years old. It represents a zone of mountain-building where large scale folding, thrusting and faulting occurred. In Ontario, the Southern Province consists mostly of metamorphic sedimentary and volcanic rocks intruded by many dikes and plutons. Within the study area, the Southern Province is represented by the Cobalt Embayment that is bound on the south by the Grenville Front Tectonic Zone.

The Grenville Province, which is the youngest part of the Canadian Shield, is characterized in Ontario by a period of widespread deformation and metamorphism. Within Ontario, it consists of two major belts, the Central Gneiss Belt and the Central Metasedimentary Belt. The two belts are separated by a deep crustal thrust zone. Only the Central Gneiss Belt is found within the study area. It consists of a variety of migmatitic rocks and gneisses that are cut by intrusive rocks. The degree of metamorphism of the belt's rocks ranges from a medium to a high grade.

A small area of metasedimentary rocks, known as the Sutton Inlier, is found within the Paleozoic rocks of the Hudson Bay basin. The Sutton Inlier is distinct from the Southern and Grenville Provinces. It is believed that it overlies the Archean basement and forms a part of the Trans-Hudson mountain-building activity (Figure 3).

5.3 PALEOZOIC AND MESOZOIC ROCKS

The Paleozoic and Mesozoic sedimentary rocks of the study area were deposited during a succession of periodic inundation of the North American continent by inland seas. Most of these rocks were deposited in the Hudson Bay and Moose River basins. They are part (approximately 240,000 km^2) of a much larger geologic structure (approximately 1.2 million km^2) known as the Hudson Platform (Sanford 1987). In addition, a small area of Paleozoic rocks is found in the Upper Ottawa River basin (Figure 4).

Johnson et al. (1992) reviewed the Paleozoic and Mesozoic stratigraphy and history of Ontario. They subdivided the record into 10 depositional sequences defined as stratigraphic intervals of genetically related sedimentary rocks. The description of the Paleozoic and Mesozoic rocks of the study area follows their subdivision.

The sedimentary rocks within the study area range in age from Lower Ordovician to Upper Cretaceous. Figures 5 to 10 show the bedrock geology of the major basins within the study area. They also show the locations of bedrock wells in these basins and the ranges of their specific capacities.

5.3.1 Lower Ordovician Strata

According to Johnson et al. (1992), the oldest sedimentary rocks within the study area are those of the shallow marine and clastic rocks of the Beekmantown Group of Lower Ordovician age. Rocks of this group have been subdivided into the March and Oxford Formations. Within the study area, the two formations are found only within the Upper Ottawa River basin. Their depositional environment ranges from supratidal to sub-tidal.

The March Formation consists of sandstones, dolomitic sandstones, sandy dolostones and dolostones. It ranges in thickness from 6 to 64 m. The Oxford Formation, on the other hand, consists of dolostones with a maximum thickness of 200 m.

5.3.2 Middle to Upper Ordovician Strata

According to Johnson et al. (1992), the Middle and Upper Ordovician strata within the study area are represented by the rocks of the Ottawa Group, Liskeard Group, Bad Cache Rapids Group, and the Boas River Formation.

The Ottawa Group, which is found in the southern tip of the Upper Ottawa River basin, has been subdivided into the Shadow Lake, Gull River, Bobcaygeon, Verulam, and Lindsay Formations. Rocks of the Shadow Lake Formation consist mainly of dolostones with interbeds of calcareous sandstones. Their thickness is generally two to three meters and their maximum thickness is about 15 m. Most likely these rocks were deposited in a near shore environment.

The Gull River Formation, with a thickness range of 7.5 to 136 m, is divided into a lower member and an upper member. The lower member consists of limestones and silty dolostones, whereas the upper member consists of limestones. It is believed that the depositional environment of the formation varied from supratidal to sub-tidal.

Rocks of the Bobcaygeon Formation have a thickness range of 7 to 87 m , and they consist mainly of limestone with some shale that were probably deposited in a shallow sub-tidal environment.

The Verulam Formation, which ranges in thickness from 32 to 65 m, consists of limestones with interbeds of shales. Most likely these rocks were deposited in an open marine environment.

The youngest unit in the sequence is the Lindsay Formation. It has a thickness of up to 67 m and contains two members. One lower member consists of limestones and a second upper member consists of limestones and calcareous shales. Most likely these rocks were deposited in a shallow to deep shelf marine environment.

The Liskeard Group is found in the "Lake Timiskaming outlier", which is found north of Cobalt within the Upper Ottawa River basin. It consists of three formations, the basal Guigues Formation, the Bucke Formation, and the Farr Formation.

Rocks of the Guigues Formation, which have a thickness of up to 51 m, rest on the Canadian Shield. They consist of conglomerates and fine-to medium-grained sandstones grading upward into non-calcareous siltstones, and their depositional environment is undetermined.

The Bucke Formation consists of up to 20 m of soft shales alternating with nodular limestones. Its upper part is rich in fossils and its lower contact with the Guigues Formation is gradational. The depositional environment of the formation is undetermined.

Rocks of the Farr Formation are rich in fossils. They consist of up to 41 m of fine-to medium-grained calcarenites that become dolomitic at the top. The depositional environment of the formation is undetermined.

The Bad Cache Rapids Group is found in the Hudson Bay and Moose River basins. The unit rests on Precambrian rocks and consists of 50 to 200 m of calcareous sandstone and siltstone grading up into cherty limestone. Its depositional environment is intertidal to sub-tidal.

Rocks of the Boas River Formation are found in the Hudson Bay basin. They consist of up to 17 m of organic-rich limestone and their depositional environment is characterized by slow deposition within a stratified basin.

5.3.3 Late Ordovician Strata

According to Johnson et al. (1992), the Late Ordovician strata within the study area are represented by the Dawson Point Formation, the Churchill River Group, and the Red Head Rapids Formation.

The Dawson Point Formation, which is part of the Liskeard Group, occurs in the Lake Timiskaming outlier and consists of up to 30 m of shales and minor limestones. Its depositional environment ranges from deltaic to shallow marine.

Rocks of Churchill River Group occur in the Hudson Platform and consist mainly of limestones and dolostones. Their thickness is between 90 to 114 m and their depositional environment is open marine.

The Red Head Rapids Formation also occurs in the Hudson Platform. It consists mainly of limestones and dolostones and ranges in thickness from 32 to 98 m. In the Hudson Bay basin, up to 20 m of halite and anhydrite have been reported in this unit. Thin intervals of anhydrite and gypsum have also been reported in the Moose River basin. The unit's depositional environment is shallow marine.

5.3.4 Early Silurian Strata

In the Lake Timiskaming outlier, the Early Silurian strata are represented by the Wabi Group. In the Hudson Platform, on the other hand, the Silurian strata commenced later with the deposition of the Severn River Formation.

The Wabi Group consists of the Manitoulin, Cabot Head, and Evanturel Creek Formations. Only the Evanturel Creek Formation is exposed in the outlier. It is about 15 m thick and consists predominantly of dolostones and shales with minor conglomerates. The other two formations were encountered in drilling. The Manitoulin Formation consists of up to 25 m of fine to very fine dolostone. Rocks of the Cabot Head Formation, on the other hand, are between 10 and 39 m in thickness and they consist of dolomitic shale, sandstone and gypsum.

The Severn River Formation was deposited in both the Moose River and Hudson Bay basins. It consists of fine-crystalline limestone and dolostone with local conglomerate beds, and it ranges in thickness from 45 to 248 m. The depositional environment for the Wabi Group and the Severn River Formation is undetermined.

5.3.5 Middle Silurian Strata

Within the Lake Timiskaming outlier, the Middle Silurian strata are represented by the Earlton and Thornloe Formations. Within the Hudson Platform, on the other hand, they are represented by the Ekwan River and Attawapiskat Formations.

Rocks of the Earlton Formation are about 62 m thick, and they consist of very fine-grained limestone and very fine-crystalline dolostone. Rocks of the Thornloe Formation, on the other hand, consist of about 70 m of massive dolostones. They are considered stratigraphically equivalent to the Amabel Formation of southern Ontario. The depositional environment for the two formations is undetermined.

The Ekwan River Formation, identified in both the Moose and Hudson Bay basins, consists of limestones and dolostones up to 235 m thick. Its depositional environment is an open marine platform.

The Attawapiskat Formation consists of dolostones and limestones. The unit is up to 62 m thick, and it was likely deposited as a barrier within a reef environment. The barrier completely encircled the Hudson Bay Basin and fringed the northern side of the Moose River basin.

5.3.6 Late Silurian Strata

Sedimentary deposits of Late Silurian age are represented by the Kenogami River Formation that occurs only in the Hudson Platform. The formation reaches a maximum thickness of about 800 m in the Hudson Bay basin. In the Moose River basin, however, it attains a thickness of only 250 m. The unit can be separated into three informal members, a lower member consisting of dolostones and minor evaporites, a middle member consisting of carbonate rocks with fluvial sandstones, and an upper member consisting of dolostone.

The depositional environment was sub-tidal and intertidal for the lower member, supratidal for the middle member, and intertidal for the upper member.

5.3.7 Early Devonian to Middle Devonian Strata

Within the study area, early to Middle Devonian strata are found only in the Hudson Platform. The strata are represented by the Sextant, Stooping River, Kwataboahegan, Moose River, and Murray Island Formations.

The Sextant Formation is geographically restricted to the southern margin of the Moose River basin and consists mainly of sandstone up to 90 m thick. It contains one of the earliest Devonian land plant assemblages, and it was possibly deposited in a marginal marine environment.

The Stooping River Formation is about 50 m thick and consists of limestone with lesser dolomitic limestone and dolostone. It is rich in fossils and unconformably overlies Precambrian, Ordovician, Silurian and Lower Devonian strata in the Moose River basin. The unit's depositional environment is intertidal to shallow sub-tidal.

Rocks of the Kwataboahegan Formation consist of limestones that range in thickness between 24 and 77 m. The rocks are extremely rich in fossils, which is an indicator of a reef marine depositional environment.

The Moose River Formation, which varies in thickness from 28 to 90 m, consists mainly of gypsum, anhydrite and carbonate deposits. In the Hudson Bay basin, the unit also contains a significant thickness of halite. The composition of the formation suggests deposition in a shallow marine environment.

The Murray Island Formation consists of limestones that are rich in fossils with halite present at their base. The unit varies in thickness from 6 to 20 m, and it was probably deposited in a shallow marine environment. Separating the Murray Island Formation from the underlying Moose River Formation, is a regional disconformity of short duration.

5.3.8 Middle Devonian to Early Mississippian Strata

Within the study area, strata of Middle Devonian to Early Mississippian age are found only in the Hudson Platform, and they are represented by the Williams Island and long Rapids Formations. The Williams Island Formation contains two members. The lower member ranges in thickness between 36 and 47 m and it consists of shale and some sandstone and limestone interbeds. The upper member, on the other hand, ranges in thickness between 70 and 90 m and it consists of limestone and some dolostone shale interbeds and a minor amount of evaporites.

It is likely that the Williams Island Formation was deposited in a sub-tidal to supratidal environment. Lithologic and faunal similarities of the formation to the Hamilton Group in southern Ontario suggest a physical connection (i.e., a seaway) between the two regions at this time (Sanford and Norris 1975).

The Long Rapids Formation is the youngest Paleozoic formation in the Hudson Platform. It overlies the William Island Formation and underlies Mesozoic and Quaternary sediments. The unit ranges in thickness from 30 to 80 m. It contains three members, a lower member consisting of mudstones and shale beds, a middle member consisting mainly of shale with minor carbonate and mudstone beds, and an upper member consisting of mudstone and minor limestone. The depositional environment of the formation is shallow marine.

5.3.9 Middle Jurassic to Late Cretaceous Strata

In Ontario, no known strata represent the Mississippian through to the Triassic periods. Middle Jurassic strata occur only within the Moose River basin and they are represented by the Mistuskwia Beds. The beds have a maximum thickness of 19 m and consist of clays with thin beds of sand and conglomerates at their base. They are lacustrine in origin and were deposited in a deltaic near shoreline environment.

Within the Moose River basin, the Mesozoic rocks are represented by the Mattagami Formation of Lower Cretaceous age. In the Hudson Bay basin, on the other hand, they are represented by the Evans Strait Formation of Lower to Upper Cretaceous age. The

Mattagami Formation ranges in thickness from 14 to 166 m. It consists of mudrock with minor amounts of sand, gravel, and lignite, which are remnants of a large, northwest-flowing river system that once drained large areas of the Canadian Shield. The Evans Strait Formation has a maximum thickness of150 m and it consists of interbedded sand and shale. Its depositional environment is shallow marine.

Following the deposition of the Mesozoic units in Ontario, all the bedrock of the province appears to have undergone a period of erosion that has continued unabated to the present. This erosion was particularly severe during the last two million years with the onset of Quaternary glaciation.

5.4 QUATERNARY GEOLOGY

A large part of the study area is obscured by a mantle, known as the overburden, of unconsolidated sediments deposited during the Quaternary Period. The period is subdivided into the Pleistocene (Great Ice Age) and the Holocene (Recent) epochs. The Pleistocene Epoch is the period when great ice sheets advanced and retreated several times over large parts of Ontario. The Holocene Epoch, on the other hand, includes post-glacial times up to and including the present. Ice advances and recessions during the Quaternary Period have played a major role in shaping the landscape of the study area, and they have left behind a variety of deposits consisting of till, gravel, sand, silt, and clay.

Within the study area, the thickness of the overburden is quite variable. Over large parts of the Canadian Shield, the thickness is less than one meter, but over the Hudson Bay Lowlands, it can exceed 200 m. According to Dredge and Cowan (1989), the overburden can exceed 100 m in thickness in some bedrock valleys of the Canadian Shield.

Figure 11 shows two geologic cross-sections in the Moose River basin and Figure 12 shows two geologic cross-sections in the Upper Ottawa River basin. The locations of the four cross-sections are shown on Figure 13. These cross-sections give an idea about the variation of the overburden thickness in the two basins. Figure 14 is a plot showing the ranges of overburden thickness reported in MOE water wells and also in the geologic logs, which were published by the Ontario Geological Survey for test holes drilled for mineral explorations and mining operations. The figure shows many wells and test holes in the Moose and Upper Ottawa River basins where the overburden thickness is more than 50 m.

Barnett (1992) in Chapter 21 of “The Geology of Ontario, Special Volume 4" provides a comprehensive description of the Quaternary geology of Ontario and an extensive list of

references related to the topic. Among other things, the chapter includes a review of major landforms and glacial deposits and a detailed description of the Quaternary geology and history of glacial lakes. In this report, the geologic descriptions of various overburden units within the study area are based on Barnett (1992) and they will be given according to their geographic location and in order of oldest to youngest units.

The Quaternary deposits of Ontario are associated with the two main glacial stages of the Pleistocene Epoch, the Illinoian and Wisconsinan, and with the interglacial Sangamonian Stage and the Holocene Epoch. Sediments, deposited before the Late Wisconsinan sub-stage, are found rarely at the surface in Ontario and are observed mainly in man-made excavations. Exposures of sediments of the Late Wisconsinan, however, are widespread and have been extensively investigated.

5.4.1 Illinoian Record

The oldest Quaternary sediments found within the study area were deposited during or possibly before the Illinoian Glaciation about 135,000 years ago. They include four till layers found beneath the interglacial Missinaibi Formation at a site along the Missinaibi River in the Hudson Bay Lowland. Three tills were reported by Terasmae and Hughes (1960a,1960b) and Skinner (1973) and a fourth till was reported by Shilts (1984a). The characteristics of these four tills are quite similar. Texturally, they are all stony sand tills. Other exposures of till and inter till sediments, believed to be older than the Missinaibi Formation, were reported in riverbank exposures within the Moose River basin.

5.4.2 Sangamonian Interglacial Record

The Sangamonian Interglacial record is represented in the Hudson Bay Lowland area by the Missinaibi Formation. Four members are found in this unit, a lower marine member, a fluvial member, a forest bed member, and an upper glaciolacustrine member.

5.4.3 Middle Wisconsinan Record

Barnett (1992) described the record of the Middle Wisconsinan in the Hudson Bay Lowland as confusing at best. As many as four till layers are believed to exist, usually separated by thin beds of stratified sediments. Two till layers were recognized in the Moose River basin separated by cross-stratified sands, and silt and clay. According to Barnett (1992) much

of northern Ontario was probably ice covered during the Early and Middle Wisconsinan. However, ice-marginal retreat into the lowlands should not be entirely ruled out.

5.4.4 Late Wisconsinan and Holocene Record

Barnett (1992) observed that in particular with respect to Ontario, the division between the Late Wisconsinan and the Holocene is arbitrary. Ten thousand years ago most of the study area was still covered by the Laurentide Ice Sheet (Figure 15). It was the beginning of a major advance of the ice margin in the Lake Superior basin, the Marquette advance, not the end of glaciation. Moraines built by the receding ice margin helped in the creation of many *glacial* lakes and in controlling their water levels, including:

- Lake Barlow that flooded areas along both the Mattawa and Ottawa Rivers as far north as Lake Timiskaming,
- Lakes Ogilvie, Ostrom, and Sultan in the headwaters of the Moose River basin,
- Lake Minong to the north of Sault Ste. Marie,
- Lake Kelvin to the south of today Lake Nipigon, and
- Lake Agassiz which extended from headwaters of the Severn River basin to the headwaters of the Abitibi River basin and beyond to the south and west.

Between 9,500 and 5,000 years ago, the following sequence of events, which affected the fate of the existing *glacial* lakes, has been suggested (Barnett 1992):

- Lake Minong expanded to its maximum size flooding land along the north shore of Lake Superior.
- The water level of Lake Agassiz began to lower by drainage eastward through the channels west of Lake Nipigon.
- Lake Kelvin formed along the ice margin in the Lake Nipigon drainage basin during the early stages of an ice-marginal retreat.
- Water level in the Lake Superior basin stabilized at the low water Houghton level about 9,000 years ago.

- A readvance of the Laurentide Ice Sheet margin to the Nakina moraine formed Lake Nakina northeast of present-day Lake Nipigon.

- Ice persisted long enough at the Nakina moraine to prevent the waters of Lake Barlow-Ojibway and post Minong Lake from coalescing.

- Northward ice-marginal retreat from the Roulier moraine, north of Cobalt, allowed Lake Barlow to expand northward and eastward and to remain in contact with the ice margin.

- Because of the isostatic rebound, Lake Ojibway came into existence.

- Ice-marginal retreat from the Nakina and Agutua moraines probably permitted lakes Agassiz and Ojibway to coalesce.

- As Ojibway and Agassiz Lakes coalesced, the entire southern margin of the Laurentide Ice Sheet in Ontario was in contact with standing water.

- Ice advances occurred along a continually retreating Laurentide Ice Sheet margin. Of these, the Cochrane advances are thought to have occurred between 8,300 and 7,900 years ago.

- About 8,000 years ago, Lake Ojibway and Lake Agassiz catastrophically drained into Hudson Bay. Water levels in the lakes lowered drastically by some 300 m and the land surrounding Hudson Bay was immediately inundated by the Tyrrell Sea.

- The Laurentide Ice Sheet appears to have quickly disintegrated in Hudson Bay leaving active ice only in northern Quebec (Labrador Sector) and in Keewatin (Keewatin Sector) on the Canadian mainland.

As the land surface became ice-free, it immediately began to rise isostatically, recovering from the weight of the ice sheet. Approximately 5,000 years ago, the Nipissing Great Lakes came into existence in the basins of Lakes Superior, Huron and Michigan and Georgian Bay.

As the isostatic rebound and erosion process continued, the Nipissing Great Lakes gradually transformed into the present Great Lakes system. Further, the Tyrrell Sea regressed to its present location.

5.4.5 Quaternary Deposits

The events during the Quaternary Period have played a major role in shaping the landscape of Ontario overall and the study area in particular. Through the abrasion and erosion processes, the Laurentide Ice Sheet incorporated a variety of rock types and sediments from the pre-glacial landscape, and it transported and dumped them as glacial deposits (tills) over a large portion of the study area.

The considerable amounts of meltwater, generated by and discharged from the glaciers, carried and deposited glaciofluvial ice-contact stratified drift and outwash deposits. Glaciolacustrine and lacustrine deposits were laid down in glacial lakes created by the impounded meltwater, and the advancing sea was a host to glaciomarine and marine deposits. Within the study area, the stratified sediments deposited by the meltwater and the advancing sea are extensive. Figures 16 to 21 show the distribution of Quaternary deposits in the Severn, Winisk, Attawapiskat, Albany, Moose, and Upper Ottawa River drainage basins. The figures also show the locations of overburden wells in these basins and the ranges of their specific capacities.

5.4.5.1 Glacial Deposits

According to Dreimanis (1988), tills are deposited by or from glacier ice with no sorting by water. As indicated earlier, four tills probably of Illinoian age have been reported at a site along the Missinaibi River in the Hudson bay Lowland. The four tills have a stony sandy texture. Other river bank exposures of old till have been identified in the Moose River basin. Further, A small amount of clayey till has also been reported in the study area (Prest 1970). The best example of such tills is the Cochrane Till which is associated with the ice surges that occurred between 8,300 and 7,900 years ago. It is a calcareous, silty clay to clay till in the area north of Timmins.

Two major types of tills are found at the surface over large parts of the study area. The first is a sandy till produced by the erosion of the Precambrian igneous and metamorphic rocks, and the second is a clayey till derived from the incorporation or deformation of fine-grained glaciolacustrine sediments. The areal extents of these tills have been mapped by the Ontario Geological Survey (OGS). Four maps of scale 1:1000,000 were published by the OGS. These are Map 2553, Map 2554, Map 2555, and Map 2556 (Barnett et al.1991).

The OGS Quaternary geologic maps show the first till as Map Unit 18. It has been mapped in most locations within the Upper Ottawa basin and within the headwaters of the Moose, Albany, Attawapiskat, Winisk, and Severn River basins. According to Barnett (1992), the

till has a sandy texture, and it is non-calcareous with an abundance of crystalline rock types. On average, sand makes up more than 70% of the till matrix with less than 5% of clay particles. The till is poorly graded, which makes it loose within the weathering zone, at depth, however, it is often compact and displays fissile structure.

Drumlin fields and De Geer moraines are associated with the till of Map Unit 18. The drumlin fields, which are found in the headwater areas of the Winisk and Severn River basins, contain many oval hills oriented mainly in a southeast-northwest direction. The drumlins are composed of a till or stratified sediments. De Geer moraines, on the other hand, consist of a series of small ridges of till and stratified sediments. These moraines are found within the headwaters of the Albany and Winisk River basins.

The OGS Quaternary geologic maps show the second till as Map Unit 21. This till covers over half the surface area of the Moose River basin and parts of the headwaters of the Albany, Attawapiskat, Winisk, and Severn River basins. According to Barnett (1992), the till is believed to be the result of the incorporation of fine-grained glaciolacustrine sediments into the base of the ice. The till is characterized by low pebble content. It contains up to 55% clay particles and 40 to70% silt particles with sand content usually below 15%.

5.4.5.2 Glaciofluvial Deposits

The origin of glaciofluvial deposits can be traced to the large volumes of meltwater discharged by glaciers. This meltwater transported large amounts of debris and deposited them either close to the glaciers or farther away in stream channels, river deltas, glacier-fed lakes or the sea. Glaciofluvial deposits are two types, ice-contact stratified drift and outwash. The Ice-contact drift occurs within or immediately next to glaciers; outwash, on the other hand, is deposited in rivers and streams beyond the glacier margin.

Deposits of the ice-contact drift have been shown on the OGS Quaternary geologic maps as Map Unit Unit 22. The make-up of these deposits is highly variable both laterally and vertically. They consist mainly of discontinuous layers of sand and gravel with some silt, clay and till. Eskers, kames, kame terraces, interlobate moraines, and ice-marginal deltas are the landforms associated with ice-contact deposits.

Many eskers are found throughout the study area and especially within the Moose River basin. These are long sinuous ridges that commonly consist of a core of gravel and sand and flanked by sand. The landforms roughly parallel the direction of local ice retreat. For example, OGS Map 2555 shows that most of the eskers within the Moose River basin are oriented in a south-north direction or a southwest-northeast direction.

Most large end moraines occur within and along the boundaries of the study area. These are ice-marginal forms that usually stand tens of meters above surrounding landscape. Some of these end moraines are several hundred kilometres long and several kilometres wide. Gravel, sand, till, and deformed pre-existing sediment and rock are commonly found in these structures.

The most notable end moraine is the Agutua Moraine that extends for several hundred kilometres through the basins of the Severn, Winisk, Attawapiskat, and Albany Rivers. The Sachigo Moraine and the northern part of the Big Beaver House Moraine are within the Severn River basin. The southern part of the Big Beaver House Moraine and parts of the Windigo and Miminiska Moraines are within the Winisk River basin. The Nakina Moraine and parts of the Crescent and Ongaman Moraines are within the Albany River basin. The Pinard Moraine is in the Moose River basin.

Outwash deposits consist of sand and gravel. The gravel is usually deposited close to the ice margin, whereas the sand is found farther downstream. Deltas formed by meltwater streams at their entrances into glacier-fed lakes are also considered outwash deposits.

Large areas within the Upper Ottawa and Moose River basins are covered with outwash deposits. Some of these deposits are closely associated with the ice-contact drift deposits, and a few exhibits excessive hummock topography. A few areas of outwash deposits are found within the Albany River basin, and practically no such deposits have been mapped within the Attawapiskat, Winisk and Severn River basins.

5.4.5.3 Glaciolacustrine Deposits

Glaciolacustrine deposits are sediments carried by glacier meltwater and subsequently deposited in glacier-fed lakes. Sand is deposited near the sediment input source, silt dominated sediments are deposited next, and clay dominated sediments are carried further into the lake basin.

Along the shores of glacial lakes, sand and gravel beaches, spits and bars, and lake plains are formed. The lake plains consist of sand, or of silt and clay with minor sand. Dredge and Cowan (1989) described the shoreline deposits of glacial Lakes Agassiz, Barlow and Ojibway as fragmented and best developed in association with eskers, kames and end moraines composed of ice-contact drift or till.

Glaciolacustrine sand plains are found in association with the Sachigo, Big Beaver House, Windigo, and Agutua Moraines. They are also found in association with smaller end

moraines and with ice-contact stratified drift in the Moose and Albany River basins. Large plains of glaciolacustrine deposits consisting of silt and clay with minor sand occur in headwaters of the Severn, Winisk, Albany, Moose, and Upper Ottawa River basins.

Large plains of glaciolacustrine deposits consisting of silt and clay with minor sand occur in headwaters of the Severn, Winisk, Albany, Moose, and Upper Ottawa River basins.

Rhythmites are a common type of glaciolacustrine sediment. Each rhythmite unit consists of a couplet composed of a sand-silt base overlain by a silt-clay layer. A thick accumulation of rhythmites has been identified by Hugh (1965) in the deposits of glacial Lakes Barlow, Ojibway, and Agassiz.

5.4.5.4 Glaciomarine Deposits

Glaciomarine deposits are sediments carried by glacier meltwater and subsequently deposited into a sea. The most common types of glaciomarine sediments are silty clays and clays. As indicated earlier, about 8,000 years ago the land surrounding Hudson Bay was inundated by sae water and the Tyrrell Sea was formed. This sea covered the lower parts of the Severn, Winisk, Attawapiskat, Albany, and Moose River basins.

The Tyrrell Sea sediments consist predominantly of clay and silt that coarsen upward into near shore and beach deposits of sand and gravel. Up to 60 m of glaciomarine sediments have been reported by Lee (1960) east of James Bay, and more than 7 m of similar sediments have been reported by Skinner (1973) in the vicinities of the Pivabiska and Missinaibi Rivers. As the sea regressed to its present location because of isostatic rebound, a series of successive beaches ringing Hudson Bay and James Bay were left behind.

5.4.5.5 Recent (Holocene) Deposits

During the Holocene Epoch, sediments consisting of peat, muck and marl accumulated in the various bogs and swamps of the study area, and fluvial sediments of gravel, sand, silt, and clay were laid down on its modern flood plains. In addition, a peat layer blanketed most of the Hudson Bay Lowland. According to Skinner (1973), up to 4 m of peat have been observed. The peat cover, however, is thin or absent near riverbanks and on raised shoreline deposits.

6. HYDROGEOLOGY

6.1 GROUNDWATER

Subsurface waters occur in two zones below the land surface, the unsaturated zone and the saturated zone. The first zone extends from the land surface down to the water table and includes the capillary fringe. This zone contains liquid water under less than atmospheric pressure and water vapour and other gases at atmospheric pressure. In parts of this zone, interstices, particularly the small ones, may be temporarily or permanently filled with water. The second zone (i.e. the saturated zone) is that zone in which all voids, large and small, are filled with water under pressure greater than atmospheric (Lohman 1972). The top boundary of the saturated zone, at which pressure is atmospheric, is called the water table.

Groundwater is that part of the subsurface water which occurs in the zone of saturation and is subject to continuous movement. The geometry and intensity of groundwater flow are dependent on the hydrologic environment, consisting of topography, climate and geology (To'th1972). The source of groundwater is from precipitation, directly by infiltration from the land surface or indirectly by surface water leaking from streams, ditches or ponds.

Land surface topography exerts a controlling influence upon the configuration of the water table, the distribution of flow systems, and groundwater movement. Further, the occurrence, movement, quality, and availability of groundwater also depend on geologic factors such as lithology, porosity, permeability and the spatial distribution of various deposits.

6.2 AQUIFERS

An aquifer is a geologic deposit that can store and transmit a large quantity of water. Aquifers vary in thickness and areal extent. Some aquifers are small and able to provide water to a few households. Others are large ranging in size from a few hectares to hundreds of square kilometres.

Aquifers may be found in the bedrock or in the overburden (unconsolidated materials) overlying the bedrock. The more fractures and openings there are in the bedrock aquifer the higher its water yield. In the overburden, aquifers consist mainly of sand and gravel. Thick deposits of coarse sand and gravel are good aquifers, while deposits of fine sand and silt suggest poor aquifers.

A deposit that has low permeability and does not furnish an adequate water supply for a well or a spring is called an aquiclude. Examples of aquicludes are clay deposits or poorly-fractured rock formations with a few interconnected pore spaces. An aquifer overlain by a confining layer that has low permeability is called an *artesian* or a *confined* aquifer. Groundwater in wells drilled in confined aquifers rises above the point where the water is found and may flow over the ground surface.

6.3 HYDRAULIC PARAMETERS

Groundwater occurs in the openings within the aquifer. These openings may be as pore spaces between the grains of silt, sand or gravel, or as solution cavities, fissures, joints and bedding planes. The ratio of the volume of the openings to the total volume of the water-bearing material is called *porosity*.

In unconsolidated deposits, porosity is controlled by the shape, arrangement, degree of sorting and cementation of particles. Porosity is high in well sorted deposits and low in poorly sorted and highly cemented deposits. In consolidated rocks, porosity is dependent on the cementation and development of the fissure system or the solution cavity openings. *Effective porosity* refers to the interconnected pore spaces or other openings that are available for water transmission.

Porosity is not a measure of the water that an aquifer will ultimately yield. The ratio of water that the rock, after being saturated, will yield by gravity to the total volume of the rock is called the *specific yield*. The specific retention is the complement of the specific yield. It is the ratio of the volume of the water that the rock, after being saturated, will retain against the force of gravity to the total volume of the rock.

The *storage coefficient* is the water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head. In an unconfined aquifer, the storage coefficient is virtually equal to the specific yield. However, in a confined aquifer, it is less than the specific yield as the water derived from storage comes from the expansion of water and compression of the aquifer. Similarly, water added to storage is held by the compression of water and expansion of the aquifer (Lohman 1972).

Groundwater flow occurs under a hydraulic gradient defined as the change in static head per unit of distance along the groundwater flow path. The relative ease with which a water-bearing material can transmit water under a hydraulic gradient is a measure of the *permeability* or *hydraulic conductivity* of the material, and is a measure of the capacity of the material to transmit water. *Transmissivity* is the rate at which water, at the prevailing

kinematic viscosity, is transmitted through a unit width of the aquifer under a unit hydraulic gradient. It is equal to the product of the hydraulic conductivity of the aquifer and its thickness.

The *specific capacity* of a well is its yield per unit of drawdown, expressed as litres per minute per metre of drawdown (L/min/m). Dividing the yield of a well by the drawdown, for a specific length of time during a pump test, gives the value of specific capacity.

The specific capacity of a well depends on the type of aquifer, well diameter, pumping time, partial penetration, hydrogeologic boundaries and well construction characteristics. Because of these constraints, the specific capacity is not an exact criterion with which to calculate the transmissivity. It is, however, a useful index to describe the water-yielding characteristics of the well and of the formation(s) the well taps. Overall, high specific capacities show high transmissivities and, consequently, high water-yielding capabilities.

In applied hydrogeology, pumping and recovery tests of wells generally give the most reliable results for determining the hydraulic constants of materials surrounding a well. Often, however, the only available data for the wells are the final drawdowns associated with pumping tests of short durations. These data can be used to calculate the specific capacity distribution for the wells and to describe the water-yielding characteristics of the formations tapped by the wells.

The hydraulic properties of an aquifer are expressed quantitatively by the hydraulic conductivity, and by the coefficients of transmissivity and storage. These properties can be estimated using pumping test data. Many methods are available to calculate the aquifer constants from pumping test data. The most widely used methods are based on:

- measurement of drawdown in an observation well during pumping,
- measurement of drawdown of the pumped well during recovery,
- drawdown-distance method, using the drawdowns in the observation and pumped wells at the end of the pumping period.

Unfortunately, only a few data on pumping tests are available for wells within the study area and most of these data are incomplete. On the other hand, thousands of specific capacity values, based on short-duration pumping tests, are available. These specific capacity data were used to describe the water-yielding capabilities of various deposits.

To determine the statistical distribution, mean, and range of the specific capacity values, a statistical analysis was applied. The values were listed in an ascending order of magnitude and assigned probabilities according to the relationship:

$$F = (100 * m) / (n + 1) \qquad (1)$$

where

F = percentage of wells where the specific capacity values are less than the specific capacity of a well of serial number m,

m = serial number of well arranged in ascending order of specific capacity,

n = total number of wells.

The specific capacity values for various units are then plotted against the percentage of wells on logarithmic probability paper. The specific capacity values for most hydrogeologic units plot approximately as straight lines, showing that the samples have log-normal frequency distributions. Therefore, it could be concluded that the most probable specific capacity value for a given hydrogeologic unit is equal to the geometric mean of its individual specific capacity values.

The 10 and 90 percentile values are the specific capacities not exceeded by 10% and 90% of the wells, respectively. They provide a measure of the dispersion of the specific capacity values. A large difference between the 10 and 90 percentiles shows a large spread and a high standard deviation. When feasible, the results of these analyses are reported as part of the description of each unit.

6.4 GROUNDWATER OCCURRENCE IN THE BEDROCK

The bedrock within the study area is a major source of water supplies to home owners, municipalities, and commercial and industrial operations. This is specifically true in areas where the overburden is absent or where the thickness of the overburden is small.

The total number of bedrock wells within the study area is 11,966 while the total number of overburden wells is 2,737. The distribution of these wells by basin is as follows:

Basin	Bedrock Wells	Overburden Wells
Severn River	78	12
Winisk River	35	10
Attawapiskat River	40	22

Albany River	223	66
Moose River	2675	1283
Upper Ottawa River	8915	1344

The above distribution shows that most of the wells are in the Moose and Upper Ottawa River basins. This reflects the fact that these two basins are in the southern part of the study area and are more heavily populated. Figures 5 to 10 show the locations of bedrock wells in the six major basins, and Figures 16 to 21 show the locations of the overburden wells in the same basins. The figures also show the ranges of the specific capacity values of the wells in L/min/m.

6.4.1 The Canadian Shield Hydrogeologic Unit

Two groundwater flow systems have been identified within the Precambrian rocks of the Canadian Shield. One shallow system, explored to a depth of about 150 m by the drilling of water wells, contains fresh water. A second deep system of brine water extends hundreds of meters in depth (Thorne and Gascoyne 1993). From a hydrogeologic point of view, the shallow groundwater system is significant as a source of water supplies especially in areas where the overburden is absent or thin.

Research to identify areas suitable for nuclear waste repositories has identified the occurrence of high salinity Ca -Na - Cl brines in the crystalline rocks of the Canadian Shield and in similar rocks outside Canada. Nuclear agencies became interested in learning more about these saline fluids, and how they may affect corrosion and transport of radioactive waste that may be buried in such deep crystalline environments. The research showed that these fluids are present at depths below the active groundwater flow systems in most crystalline rock environments, and that they are enriched in deuterium. The origin of these fluids and their age are still under investigation.

The shallow groundwater system is characterized by many small, localized aquifers. In most parts of the study area, groundwater in the overburden and in the bedrock may be hydraulically connected. Surficial aquifers are bedrock controlled with the overburden being thickest in the bedrock valleys and thinning towards the tops of ridges. Multiple layered aquifer/aquitard hydrogeological settings appear to be rare. Data are insufficient to define the shape of the water table within the study area. Based on the finding in southern Ontario, however, the water table is likely a subdued replica of the surface topography.

Significant movement of groundwater in the shallow bedrock is entirely dependent on the secondary permeability created by the fractures in the rock. Lineament analysis of space

images, conducted at Goddard Space Flight Centre, has been particularly valuable in determining regional and subcontinental fracture patterns within the Canadian Shield (Short 2002). The images show that, where soil and glacial cover are small, the Shield contains a very high density of fractures. It is possible that these fractures have developed at the time of emplacement of the individual terrains that collided and assembled to form the Shield.

The fracture systems within the Superior and Grenville Provinces were investigated. Many fractures in each province stand out as linear glacially-scoured gouges that are now filled with water. When the orientations of the lineaments are plotted in rose diagrams for each province, two characteristics emerge. The first characteristic is that both provinces have a dominant east-northeast fracture trend. The second is that the Superior Province has an extra north-northeast dominant trend, and the Grenville Province has an extra north-northwest trend.

The intensity and distribution of the fracture systems play a major role in determining the total porosity of the rocks of the Canadian Shield, their hydraulic conductivity, water yield, and groundwater recharge. The determination of total porosity is highly site-specific, however, and cannot be done without field observations.

The hydraulic conductivity of a fracture zone depends on the degree of crushing, the presence of fracture filling, and the characteristics of the individual fractures. According to Ericsson and Ronge (1986), tension fractures, called joints, are generally more conductive than faults. Since these joints become narrower and smaller with depth, the bulk hydraulic conductivity of the rock should decrease with depth. Further, due to the fact that the well yield is dependent only on the hydraulic properties of the area close to the well, the relationship between a well yield and the distance to fractures and faults is expected to be weak.

Many studies have been conducted in Ontario for areas containing parts of the Canadian Shield. Sibul et al. (1974), assessed the groundwater resources of the Moira River basin. The authors showed that approximately 85% of 400 wells drilled in Precambrian rocks within the basin obtain suitable water supplies within 15 m of the ground surface. Five percent of the wells failed to supply sufficient water for domestic use, and 40% yielded less than 10.0 L/min. Well yields of more than 2,000.0 L/min, however, have been reported for some municipal wells at Deloro, Madoc, and Tweed. According to Sibul et al. (1974), the groundwater yield from the Precambrian rocks depends on the number and size of fractures and joints encountered by the well. Because these openings can begin and end abruptly and because they possess strong directional orientations, well yields in the Precambrian rocks are highly variable.

Wang and Chin (1978) assessed the groundwater resources of five northern Ontario basins draining into the Hudson Bay and James Bay. As part of their study, 16 test holes were constructed in the Albany River basin. The degree and extent of fractures in the Precambrian rocks were inferred from rock cores collected from the16 test holes. Core recoveries ranged from 97% to 99% which shows that the rocks have generally few fractures. Injection tests in the same holes showed that the permeability of the rocks varies greatly. In some intervals, the water losses were very small showing a few fractures and low permeability, in others, the water losses were very large showing a highly fractured rock and high permeability. The rate of water loss was used to compute an average permeability of less than 0.1 m/day for the Precambrian rocks in the Albany River basin.

According to Wang and Chin (1978), an additional 33 test holes were constructed at seven sites in the Precambrian rocks within the Attawapiskat, Winisk, and Severn River basins. Average core recovery from the test holes ranged from 80% to 100%, and the degree and extent of fractures in the Precambrian rocks was inferred from the collected cores. According to the authors, the cores showed that the Precambrian rocks in the three basins contained a few fractures. Most of these fractures occurred at less than 12 m below the bedrock surface although some were found up to 48 m below the bedrock surface. Injection tests in the same holes showed that the mean permeability values for the Precambrian rocks in the three basins were generally of the same magnitude as those for the Albany River basin.

In addition, Wang and Chin (1978) examined data related to short-term pumping tests for 74 wells in the Albany River basin, 932 wells in the Moose River basin, and four test holes in the Severn River basin. The data were used to determine the mean specific capacity and transmissivity values for the wells that taped water in the rocks of the Canadian Shield. The results showed that the wells constructed in the Albany River basin had a mean specific capacity of 1.8 L/min/m and a mean transmissivity of 2.9 m^2/day. The wells constructed in the Moose River basin, on the other hand, had a mean specific capacity of 2.06 L/min/m and a mean transmissivity of 3.1 m^2/day.

The transmissivities for the four test holes in the Severn River basin were 1.5, 6.0, 7.1, and 28.2 m^2 /day. According to Wang and Chin (1978), the high transmissivity value of 28.2 m^2 /day for one of the test holes reflects, most likely, the combined transmissivity of the Precambrian rocks and the sand till which may be providing some water to the well.

Ostry and Singer (1981) reported on the hydraulic conductivity of 179 wells completed in the Precambrian rocks within the Thousand Islands area. The hydraulic conductivity values for the wells ranged from 10^{-5} m/day to 1.3 m/day with a mean of 0.1 m/day.

Singer et al. (1997) examined the records of 12,381 wells in areas where the Precambrian rocks occur at the surface in southern Ontario. Of these, a sample of 7,875 wells was selected to determine the specific capacity and transmissivity distributions for the wells.

The authors showed that 5,158 (65.5%) wells in the sample had specific capacity values less than 5.0 L/min/m. Most wells (2,274 or 28.8%), however, showed good specific capacity values ranging from 5.0 to 50.0 L/min/m, and a minority of wells (50) had specific capacity values higher than 50.0 L/min/m.

The transmissivity distribution for the wells in the sample was derived from the specific capacity data. According to Singer et al. (1997), the transmissivity values plot approximately as a straight line on a transmissivity-probability graph, suggesting that the sample has a log-normal distribution. The 10 and 90 percentile values were 0.40 and 42.5 m^2/day, and the geometric mean of the sample's transmissivity distribution was 4.2 m^2/day. Given the large number of wells in the sample, Singer et al. (1997) concluded that the sample's transmissivity distribution represents the water-yielding capability of the Precambrian hydrogeologic unit in southern Ontario. The low value of the distribution's geometric mean suggested a poor water-yielding capability for the unit.

In this study, the records of 10,022 wells in the Canadian Shield were examined. Of these, a total of 717 wells has been reported as dry. In all the productive wells, water was found at depths of 280.4 m or less. Approximately 90% of the wells, however, obtain water at depths of 67.1 m or less. Also, more than 50% of the wells obtain water at depths of 28.4 m or less.

The productivity of the wells was assessed from data obtained from short-term pumping tests. The available well records for the study area show that 8,366 wells, constructed in the Canadian Shield, have data related to short-term pumping tests. An examination of the specific capacity values, calculated from the pumping test data, showed the following:

Specific Capacity Range (L/min/m)	**Number of Wells**	**% of Wells**
0 - 1	2,539	30.3
1 - 5	3,104	37.1
5 - 10	835	10.0
10 - 50	874	10.5
> 50	1,014	12.1

The above specific capacity data are very similar to those data obtained from wells constructed in the Canadian Shield in southern Ontario.

6.4.2 The Paleozoic and Mesozoic Hydrogeologic Units

From an applied hydrogeologic point of view, only those water-bearing formations that are at or close to the surface are of interest as potential aquifers. When such formations are very deep, they become less attractive as potential sources of water supply. Further, the water quality in such formations is also very important. Fresh water supplies that meet the Ontario Drinking Water Standards and Objectives are much preferred to brackish water.

The Paleozoic and Mesozoic formations within the study area that are at or close to the surface contain limestones, dolomites, sandstone, and siltstones. These rocks can be excellent water-bearing formations and could serve as good aquifers provided that their water quality is acceptable.

Within the Severn River basin consecutive layers of Paleozoic rocks are close to the surface (Figure 5). These include the following rocks:

- Bad Cache Rapids Group (sandstones, siltstones),
- Churchill River Group (limestones, dolostones),
- Redhead Rapids Formation (limestones and dolostones),
- Severn River Formation (limestones and dolostones),
- Ekwan Formation (limestones, dolostones),
- Attawapiskat Formation (dolostones, limestones),
- Kenogami River Formation (dolostones, evaporites).

While the Kenogami River Formation is missing in the Winisk River basin, all the other groups and formations are present (Figure 6). The Attawapiskat River basin contains the rocks of the same groups and formations found in the Severn River basin (Figure 7).

The Albany River basin contains the following formations:

- Redhead Rapids Formation (limestones and dolostones),
- Severn River Formation (limestones and dolostones),
- Ekwan Formation (limestones, dolostones),
- Attawapiskat Formation (dolostones, limestones),
- Kenogami River Formation (dolostones, evaporites),
- Stooping River Formation (limestones, dolostones),
- Kwataboahegan Formation (limestones),
- Moose River Formation (Gypsum, anhydrite, carbonate rocks),
- Williams Island Formation (shales, sandstones, limestones),
- Mattagami Formation (mudrocks) (Figure 8).

The Moose River basin contains the following formations:

- Kenogami River Formation (dolostones, evaporites),
- Sextant Formation (sandstones),
- Stooping River Formation (limestones, dolostones),
- Kwataboahegan Formation (limestones),
- Moose River Formation (Gypsum, anhydrite, carbonate rocks),
- Murray Island Formation (Limestones, halite),
- Williams Island Formation (shales, sandstones, limestones),
- Long Rapids Formation (mudstones, shales),
- Mattagami Formation (mud rocks) (Figure 9).

The Upper Ottawa River basin contains the rocks of the following groups and formations:

- Beekmantown Group (dolostones, sandstones),
- Ottawa Group (sandstones, limestones),
- Wabi Group (limestones, dolostones, shales, gypsum),
- Liskeard (sandstones, siltstones, shales, limestones),
- Earlton Formation (limestones, dolostones),
- Thornloe Formation(dolostones) (Figure 10).

The majority of well records on file with the MOE that are related to the Paleozoic rocks are within the Upper Ottawa River basin. Less than 50 records are for wells located in the remaining parts of the study area, and most of them are for test holes drilled by the MOE and the Canada Department of the Environment. Given the tremendous areal extent of the Paleozoic and Mesozoic rocks within the study area, the available information is extremely inadequate to draw any meaningful conclusions about the water-yielding capabilities of these rocks.

One way to identify *potential aquifers* within the Paleozoic and Mesozoic rocks is by lithology. Based on lithological criteria, the following potential aquifers, listed from oldest to youngest, have been identified:

Potential Aquifer	**Rock Type**
Beekmantown Group	dolostones, sandstones
Ottawa Group	sandstones, limestones
Wabi Group	limestones, dolostones, shales, gypsum
Liskeard Group	sandstones, siltstones, shales, limestones
Earlton Formation	limestones, dolostones
Thornloe Formation	dolostones
Bad Cache Rapids Group	sandstones, siltstones
Churchill River Group	limestones, dolostones
Redhead Rapids Formation	limestones and dolostones
Severn River Formation	limestones and dolostones

Ekwan Formation	limestones, dolostones
Attawapiskat Formation	dolostones, limestones
Kenogami River Formation	dolostones, evaporites
Sextant Formation	sandstones
Stooping River Formation	limestones, dolostones
Kwataboahegan Formation	limestones
Moose River	Gypsum, anhydrite, carbonate rocks
Murray Island Formation	limestones, halite
Williams Island Formation	shales, sandstones, limestones
Mattagami Formation	mud rocks

Groundwater quality within the Kenogami River, Moose River, and Murray Island Formations is expected to be adversely affected by the presence of gypsum, anhydrite, and halite minerals. Limited amount of data is available regarding the water quality within the Hudson Bay Lowland. Given the low topography of this area, and the fact that it was under the sea very recently suggest that groundwater quality may be very poor.

Wang and Chin (1978) grouped the Paleozoic and Mesozoic rocks in areas draining into Hudson Bay and James Bay into five aquifer types based on their lithology. Using this criterion, the authors identified limestone, limestone/dolomite, sandstone/limestone, sandstone/siltstone, and carbonaceous shale aquifers. They also described the extent of fractures and the hydraulic properties of the limestone/dolomite aquifer and the sandstone/limestone aquifer.

The extent of fractures in the limestone/dolomite rocks in the Albany River basin was obtained by Wang and Chin (1978) from examinations of core samples collected from 30 test holes drilled along the Albany River. The core examinations suggested that secondary porosity has developed along the fractures and joints, but none of the cores indicated large cavities.

Information about the hydraulic properties of the limestone/dolomite rocks was obtained from short-term pumping tests and in situ injection tests. According to Wang and Chin (1978), two short-term pumping tests on wells No.1759 and No.1760 in the Moose River basin gave transmissivity values of 79.0 and 196.8m^2 /day, respectively. Short-term pumping tests on 11 test holes in the Albany River basin gave transmissivity values ranging from 7.3 to 536.8m^2/day with a mean of 79.0m^2/day. In addition, information obtained from in situ injection tests on 18 test holes in the same basin gave permeability values ranging from 5x 10^{-3} to 3.2 m/day with an average of 0.5 m/day.

Based on recovered rock cores from six test holes drilled at the Buffaloskin site within the Albany River basin, and in the Pym Island site within the Attawapiskat River basin, Wang and Chin (1978) suggested that the secondary openings in the sandstone/limestone rocks were formed by the dissolution of carbonate material along joints and fractures. Aquifer

permeability values were determined from ten in situ injection tests conducted on test holes No. 657 and No.1700. The obtained permeability values ranged from $5x10^{-3}$ to1.5 m/day with an average of 0.2 m/day. The transmissivity of the sandstone/limestone rocks was estimated to be in the range of 6.7 m^2/day, and the water-yield of individual wells in the sandstone/limestone rocks was estimated to be up to 115.0 L/min.

Based on recovered rock cores from 8 test holes at the Chard and Biglow sites within the Albany River basin, Wang and Chin (1978) concluded that the sandstone/siltstone rocks contain abundant secondary openings. The permeability values for these rocks were determined from 53 in situ injection tests conducted on eight test holes and they ranged from $5x10^{-3}$ to 5.4 m/day with an average of 0.5 m/day. A transmissivity value of 6.1 m^2/day was computed from a short-term pumping test conducted on test hole No. 653, and another value of 41.7 m^2/day was determined on the basis of permeability obtained for test hole No. 1695. The water yield of individual wells in the sandstone/siltstone rocks was estimated to be up to 115.0 L/min.

In this study, a total of 1,944 wells has been identified in the Paleozoic rocks. The vast majority of these wells are located within the Upper Ottawa River basin. Of these wells, 68 have been reported to be dry. In all the productive wells, water was found at depths of 155.1 m or less. In 90% of the wells water was found at depths of 65.5 m or less, and in 50% of the wells water was found at 30.8 m or less.

The vast majority of the wells in the Paleozoic rocks are constructed in the Beekmantown Group (Lower Ordovician), Ottawa Group (Middle and Upper Ordovician), Liskeard Group (Middle and Upper Ordovician), Wabi Group (Lower and Middle Silurian), and the Thornloe and Earlton Formations (Middle Silurian).

6.4.2.1 The Beekmantown Group Hydrogeologic Unit

Rocks of the Beekmantown Group have been identified within the lower tip of the Upper Ottawa River basin. In eastern Ontario, this group consists of the March and Oxford Formations. In this study, a total of 66 wells has been identified within the Beekmantown Group hydrogeologic unit. Of these, the records of 62 wells contain information related to short-term pumping tests. The specific capacity values calculated from these tests showed the following:

Number of Wells	Percent of Wells	Specific Capacity (L/min/m)
8	12.9	< 1.0
34	4.8	1.0 - 5.0
8	12.9	5.0 -10.0

9	14.5	10.0 - 50.0
3	4.8	> 50.0

In an assessment of the hydrogeology of southern Ontario, Singer et al. (1997) treated the Nepean Formation of Upper Cambrian age and the March and Oxford Formations of Lower Ordovician age as one hydrogeologic unit. The reason for this decision was the fact that the three formations have similar lithological composition (dolostones and sandstones).

A total of 17,642 wells within the Nepean-Oxford-March hydrogeologic unit was identified by Singer et al. (1997). Of these, a sample of 7,418 wells was selected to determine the specific capacity and transmissivity distributions for the wells within the unit. The specific capacity data showed the following:

Number of Wells	**Percent of Wells**	**Specific Capacity (L/min/m)**
339	4.5	< 1.0
1,884	25.4	1.0 - 5.0
1,466	19.7	5.0 -10.0
3,025	40.7	10.0 - 50.0
697	9.3	> 50.0

The transmissivity values for the wells in the sample were derived from the specific capacity data. The 10 and 90 percentile values were estimated to be 0.5 and 120.5 m^2/day, respectively, and the geometric mean of the sample's transmissivity distribution was estimated to be 20.1 m^2/day. Given the large number of wells in the sample, Singer et al. (1997) concluded that the sample's transmissivity distribution represents the water-yielding capability of the Nepean-March-Oxford hydrogeologic unit. The high value of the distribution's geometric mean suggested that the unit has a good water-yielding capability.

By comparing the specific capacity values for the Beekmantown Group hydrogeologic unit within the study area and those values reported for the Nepean-March-Oxford unit in southern Ontario, the values for the Beekmantown Group are much smaller. This could be due to the limited thickness and areal extent of this unit within the study area or more likely because of the small size of the data.

6.4.2.2 The Ottawa Group Hydrogeologic Unit

The rocks of the Ottawa Group have been identified within the Upper Ottawa River basin. In their assessment of the hydrogeology of southern Ontario, Singer et al. (1997), identified a total of 10,357 wells within the Ottawa Group hydrogeologic unit. Of these, a sample of

7,251 wells was selected to determine the specific capacity and transmissivity distributions for the wells within the unit.

The minimum and maximum specific capacity values were estimated to be 0.1 and 2,610.0 L/min/m, respectively. The 10 and 90 percentile values were estimated to be 0.8 and 33.9 L/min/m, respectively, and the geometric mean of the sample's specific capacity distribution was estimated to be 5.9 L/min/m.

The minimum and maximum transmissivity values, derived from the sample's specific capacity data, were estimated to be 0.1 and 8,082.0 m^2/day, respectively. The 10 and 90 percentile values were estimated to be 1.3 and 70.9 m^2/day, respectively, and the geometric mean of the sample's transmissivity distribution was estimated to be 11.7 m^2/day.

Based on the large number of wells in the sample, Singer et al. (1997) concluded that sample's transmissivity distribution represents the water-yielding capability of the Ottawa Group hydrogeologic unit. The high value of the distribution's geometric mean suggested that the unit has a good water-yielding capability.

In this study, a total of 1,184 wells has been identified within the Ottawa Group hydrogeologic unit. Of these, the records of 1,095 wells contain information related to short-term pumping tests. The specific capacity values calculated from these tests showed the following:

Number of Wells	**Percent of Wells**	**Specific Capacity (L/min/m)**
253	23.1	< 1.0
422	38.5	1.0 - 5.0
151	13.8	5.0 -10.0
168	15.3	10.0 - 50.0
101	9.2	> 50.0

6.4.2.3 The Liskeard Group Hydrogeologic Unit

Rocks of the Liskeard Group have been identified within the Lake Timiskaming outlier, which is north of Cobalt in the Upper Ottawa River basin. The group consists of sandstones, siltstones, shales, and limestones.

In this study, a total of 76 wells has been identified within the Liskeard Group hydrogeologic unit. Of these, the records of 55 wells contain information related to short-

term pumping tests. The specific capacity values calculated from these tests showed the following:

Number of Wells	Percent of Wells	Specific Capacity (L/min/m)
17	30.9	< 1.0
18	32.7	1.0 - 5.0
4	7.3	5.0 -10.0
7	12.7	10.0 - 50.0
9	16.4	> 50.0

Due to the limited amount of the available data, it is not possible to make definite conclusions about the water-yielding capabilities of this hydrogeologic unit.

6.4.2.4 The Wabi Group Hydrogeologic Unit

Rocks of the Wabi Group have also been identified within the Lake Timiskaming outlier in the Upper Ottawa River basin. The group consists predominantly of dolostones and shales with minor conglomerates, sandstone and gypsum.

In this study, a total of 62 wells has been identified within the Wabi Group. Of these, the records of 49 wells contain information related to short-term pumping tests. The specific capacity values calculated from these tests showed the following:

Number of Wells	Percent of Wells	Specific Capacity (L/min/m)
18	36.7	< 1.0
10	20.4	1.0 - 5.0
7	14.3	5.0 -10.0
6	12.2	10.0 - 50.0
8	16.3	> 50.0

Due to the limited amount of the available data, it is not possible to make definite conclusions about the water-yielding capabilities of this hydrogeologic unit.

6.4.2.5 The Earlton-Thornloe Hydrogeologic Unit

Rocks of the Earlton and Thornloe Formations have also been identified within the Lake Timiskaming outlier in the Upper Ottawa River basin. The Earlton Formation consists of limestones and dolostones and the Thornloe Formation consists of dolostones.

In this study, a total of 524 wells has been identified within this hydrogeologic unit. Of these, the records of 401 wells contain information related to short-term pumping tests. The specific capacity values calculated from these tests showed the following:

Number of Wells	Percent of Wells	Specific Capacity (L/min/m)
31	7.7	< 1.0
127	31.7	1.0 - 5.0
86	21.4	5.0 -10.0
108	26.9	10.0 - 50.0
49	12.2	> 50.0

The above specific capacity data, although limited, show that the unit has good water-yielding capabilities.

6.5 GROUNDWATER OCCURRENCE IN THE OVERBURDEN

As with the bedrock, the overburden in the study area is a major source of water supplies to home owners, municipalities, and commercial and industrial operations. Although surface water is abundant within the study area, the high levels of organic matter in the water create problems. As an alternative, shallow wells are frequently dug in the overburden to supply cottages and homes with a more reliable water supply that is free of bacteria.

The overburden deposits within the study area consist mainly of glacial, glaciofluvial, glaciolacustrine, glaciomarine deposits. As a rule, thick sands and gravels that are usually found in eskers, kames, outwash plains, and interlobate moraines can act as good aquifers. These deposits usually have high water supply potentials with transmissivities of about 10.0 to 100.0 m^2/s and well yields up to 50.0 L/s. Thick sandy tills also can act as good aquifers and have transmissivities ranging from 10^{-4} to 10^{-5} m^2/s and yield up to 2.0 L/s. Further, experience in southern Ontario shows that even some silty and clay tills, which have usually low hydraulic conductivity values, contain, at times, sand lenses of various dimensions that can provide adequate water supplies to a home or a school. Thick varved clays of glaciolacustrine or glaciomarine origin, however, have extremely low vertical

hydraulic conductivities between 10^{-8} and 10^{-11} m^2/s. Such deposits are considered aquicludes.

Wang and Chin (1978) collected about 150 samples of various overburden materials in the Severn, Winisk, Attawapiskat, Albany, and Moose River basins and determined their grain size distributions. A simplified stepwise regression procedure was used to estimate the hydraulic conductivity for 122 samples. The following results were reported:

Number of Samples	Type of Material	Hydraulic Conductivity (m/day)
39	Fluvial sand and gravel	0.1 - 34.2
22	Glaciolacustrine sand	0.2 - 24.5
12	Sandy till	0.3 - 4.9
39	Clayey till	0.0009 - 0.02
14	Clay and silt	0.0002 - 0.004

In addition, Wang and Chin (1978) used the information regarding short-term pumping tests to estimate the values of the transmissivity, specific capacity, and probable well yield for 504 wells. Of these, 43 wells were in sand and gravel materials and 461 wells were in sand or sand till materials.

According to Wang and Chan (1978), the sand and gravel wells have transmissivities ranging from 7.5 to 1,282.3 m^2/day and a geometric mean of 74.5 m^2/day. These wells have also a specific capacity range of 0.3 to 51.3 L/min/m and a probable yield range of 45.5 to 4,546.2 L/min. The sand and sand till wells, on the other hand, have transmissivities ranging from 0.9 to 42.3 m^2/day and a geometric mean of 5.0 m^2/day. The wells have also a specific capacity range of 0.1 to 4.2 L/min/m and a probable yield range of 4.5 to 300.0 L/min.

As indicated earlier, the total number of overburden wells within the study area is 2,737 and most of these wells are located in the Upper Ottawa and Moose River basins. Figures 16 to 21show the locations of the overburden wells in six major basins within the study area. The figures also show five different categories of specific capacity ranges for these wells in L/min/m.

An examination of the available well records for the overburden wells shows that a total of 309 wells has been reported as dry. In all the productive wells, water was found at depths of 143.9 m or less. Approximately 90% of the wells obtain water at depths of 50.3 m or less. Further, more than 50% of the wells obtain water at depths of 23.5 m or less.

6.5.1 Overburden Aquifers

The available data regarding groundwater occurrence in the overburden within the study area is very limited and does not allow for a detailed description of the overburden aquifers. From a geologic point of view, however, the sand and gravel deposits of glaciofluvial, glaciolacustrine, glaciomarine, and recent origin could act as important aquifers. As part of the assessment of the hydrologic budgets for seven river basins within the study area, seven streamflow gauges placed as close as possible to the outlets of these rivers were selected. The areal distributions of sand and gravel within the gauged areas in these basins and also within the whole study area were determined using the ArcView GIS system. The results are as follows:

River Basin	Sand and Gravel as % of Gauged Area	Area km^2
Severn	5.5	4,989
Winisk	4.5	3,063
Attawapiskat	6.4	3,679
Albany	11.8	16,193
Moose	13.4	12,972
Montreal	18.7	1,206
Petawawa	20.9	1,234

The total areal extent of the sand and gravel deposits is about is about 51,300 km^2 or 8.3% of the study area. This is about half the size of southern Ontario. These deposits are potential significant aquifers. Figures 22 to 27 show the areal distribution of the sand and gravel deposits of different origins within the various basins. The following sections use the available information from the water well records to assess the water-yielding capabilities of four types of sand and gravel deposits and two types of tills.

6.5.2 Groundwater Occurrence in Glaciofluvial Ice-Contact Drift Deposits

As indicated earlier, the ice-contact drift deposits consist mainly of discontinuous layers of sand and gravel with some silt, clays and till. These deposits are found within the study area as eskers, kames, kame terraces, interlobate moraines, and ice-marginal deltas.

A total of 200 wells has been identified in areas where the ice-contact drift deposits are displayed at the surface within the study area. Of these, 160 wells have data related to short-term pumping tests. The specific capacity values calculated from these data showed the following:

Number of Wells	Percentage of Wells	Specific Capacity (L/min/m)
19	11.9	< 1.0
48	30.0	1.0 - 5.0
24	15.0	5.0 -10.0
48	30.0	10.0 - 50.0
21	12.2	> 50.0

Due to the limited amount of the available data, it is not possible to make definite conclusions about the water-yielding capabilities of this hydrogeologic unit.

6.5.3 Groundwater Occurrence in Glaciofluvial Outwash Deposits

The outwash deposits consist of sand and gravel and they cover large areas within the Upper Ottawa and Moose River basins. A few areas of outwash deposits are also found within the Albany River basin, but practically no such deposits have been mapped within the Attawapiskat, Winisk and Severn River basins.

A total of 306 wells has been identified in areas where the outwash deposits are displayed at the surface within the study area. Of these, 249 wells have data related to short-term pumping tests. The specific capacity values calculated from these data showed the following:

Number of Wells	Percentage of Wells	Specific Capacity (L/min/m)
14	5.6	< 1.0
63	25.3	1.0 - 5.0
35	14.1	5.0 -10.0
90	36.1	10.0 - 50.0
47	18.9	> 50.0

Due to the limited amount of the available data, it is not possible to make definite conclusions about the water-yielding capabilities of this hydrogeologic unit.

6.5.3 Groundwater Occurrence in Sand and Gravel Deposits of Glaciolacustrine Origin

A total of 146 wells has been identified in areas where glaciolacustrine sand deposits are displayed at the surface within the study area. Of these, 118 wells have data related to short-term pumping tests. The specific capacity values calculated from these data showed the following:

Number of Wells	Percentage of Wells	Specific Capacity (L/min/m)
10	8.5	< 1.0
54	45.8	1.0 - 5.0
23	19.5	5.0 -10.0
22	18.6	10.0 - 50.0
9	7.6	> 50.0

Due to the limited amount of the available data, it is not possible to make definite conclusions about the water-yielding capabilities of this hydrogeologic unit.

6.5.5 Groundwater Occurrence in Sand and Gravel Deposits of Glaciomarine and Marine Origin

A total of 38 wells has been identified in areas where sand deposits of glaciomarine and marine origin are displayed at the surface within the study area. Of these, 36 wells have data related to short-term pumping tests. The specific capacity values calculated from the data showed the following:

Number of Wells	Percentage of Wells	Specific Capacity (L/min/m)
5	13.9	< 1.0
6	16.7	1.0 - 5.0
8	22.2	5.0 -10.0
12	33.3	10.0 - 50.0
5	13.9	> 50.0

Due to the limited amount of the available data, it is not possible to make definite conclusions about the water-yielding capabilities of this hydrogeologic unit.

6.5.6 Groundwater Occurrence in the Till of Map Unit 18

As indicated earlier, the till of Map Unit 18 has been mapped in many locations within the Upper Ottawa River basin and within the headwaters of the Moose, Albany, Attawapiskat, Winisk, and Severn River basins. The till is commonly sandy in texture and non-calcareous with an abundance of crystalline rock types. On average, sand makes up more than 70% of the till matrix. Clay-sized particles in the till are usually less than 5%. The till is poorly graded, which makes it loose within the weathering zone. At depth, however, it is often compact and displays fissile structure.

A total of 88 wells has been identified in areas where this till is displayed at the surface within the study area. Of these, 65 wells have data related to short-term pumping tests. The specific capacity values calculated from these data showed the following:

Number of Wells	Percentage of Wells	Specific Capacity (L/min/m)
12	18.5	< 1.0
18	27.7	1.0 - 5.0
9	13.8	5.0 -10.0
14	21.5	10.0 - 50.0
12	18.5	> 50.0

Due to the limited amount of the available data, it is not possible to make definite conclusions about the water-yielding capabilities of this hydrogeologic unit.

6.5.7 Groundwater Occurrence in the Till of Map Unit 21

As indicated earlier, the till of Map Unit 21 covers over half the surface area of the Moose River basin and parts of the headwaters of the Albany, Attawapiskat, Winisk, and Severn River basins. The till is characterized by low pebble content and it contains up to 55% clay-sized particles, 40 to70% silt, with sand content usually below 15%.

A total of 172 wells has been identified in areas where this till is displayed at the surface within the study area. Of these, 117 wells have data related to short-term pumping tests. The specific capacity values calculated from these data showed the following:

Number of Wells	Percentage of Wells	Specific Capacity (L/min/m)
14	12.0	< 1.0
63	53.8	1.0 - 5.0
15	12.8	5.0 -10.0
17	14.5	10.0 - 50.0
8	6.8	> 50.0

Due to the limited amount of the available data, it is not possible to make definite conclusions about the water-yielding capabilities of this hydrogeologic unit.

6.6 A Comparison between the Water-Yielding Capabilities of the Bedrock and the Overburden

The specific capacity data for wells completed in the Precambrian, Paleozoic and overburden deposits were tabulated in order of magnitude and frequencies were computed using equation (1). Values of the specific capacity were then plotted against percentage of wells on logarithmic probability paper (Figure 28).

As Figure 28 shows, the specific capacity data for the various types of deposits plot approximately as straight lines on the logarithmic probability paper suggesting that the data have log-normal probability distributions. Therefore, it could be concluded that the most probable specific capacity value for a well completed in a given type of deposit is equal to the geometric mean of its specific capacity distribution. On the log-probability plot, this corresponds to the specific capacity value at the 50 percent probability level.

By comparing the probability plots for the various deposits, it is possible to conclude that the overburden wells have the highest water-yielding capabilities, with a geometric mean value for their specific capacity distribution of 5.0 L/min/m. The wells completed in the Paleozoic rocks show lower water-yielding capabilities, with a geometric mean value for their specific capacity distribution of 2.5 L/min/m. Finally, the wells completed in the Precambrian rocks show the lowest water-yielding capabilities, with a geometric mean value for their specific capacity distribution of 1.9 L/min/m.

7. 0 WATER BUDGET CALCULATIONS

7. 1 GENERAL REMARKS

The water budget provides a summary of the hydrologic cycle within a basin. The calculations associated with the assessment of a water budget consider the amount of precipitation that falls on the basin, the amount of water that is returned back to the atmosphere through actual evapotranspiration, the amount of water that becomes surface runoff, and, when possible, the changes in soil moisture storage and groundwater storage.

The water budget equation can be expressed as follows:

$$P = R + AET \pm Cs \pm Cg \qquad (2)$$

where

P	=	precipitation,
R	=	runoff,
AET	=	actual evapotranspiration,
Cs	=	change in soil moisture storage,
Cg	=	change in groundwater storage.

For best results, precipitation should be estimated from data obtained at several points distributed strategically throughout the basin. When such data are not available, it becomes necessary, at some cost in accuracy, to use precipitation data measured at one station within or outside the basin.

Surface runoff which includes groundwater discharge (baseflow) is usually obtained from measurements made at streamflow gauging stations that are located at various points within the basin. If such data are not available, statistical or modelling techniques can be used to generate the data. This, however, would add considerable uncertainty to the calculations. Surface runoff data are extremely useful in groundwater investigations because they can be used to estimate groundwater discharge by means of appropriate streamflow separation techniques.

Potential evapotranspiration can be estimated using temperature data measured within or in the vicinity of the basin. Actual evapotranspiration estimates, on the other hand, can be made using soil moisture budget techniques that make use of data related to precipitation and soil moisture capacity.

If soil moisture measurements made in various soils within the basin are available, the changes in soil moisture storage can be calculated for each soil type and for the whole basin. If such measurements, on the other hand, are not available then the combined

changes in the soil moisture storage and groundwater storage can be calculated by knowing the values of the remaining components of the water budget equation.

As indicated earlier, seven meteorological stations have been identified within the study area. A summary of the names, numbers, and locations of these stations is as follows:

River Basin	Station Name	Station Number	Period of Record
Severn	Big Trout Lake	6010738	1954-91
Winisk	Winisk	6019548	1970
Attawapiskat	Lansdowne House	6014350	1947-88
Albany	Fort Albany	6072460	1987-88
Moose	Moosonee	6075425	1982-93
Upper Ottawa River	Lake Traverse	6084307	1966-86
Upper Ottawa River	New Liskeard	6075594	1967-73, 77-79, 82-83

The above summary shows that none of the meteorological stations is currently in use. Further, the period and continuity of records collected at the various stations are highly variable which make it difficult to compare the climatological data and the calculated water budgets for the various basins.

7. 2 TEMPERATURE

Air temperature regulates the circulation of the weather systems, determines the type of precipitation, and controls the varieties of plant and animal species within an area. It is also an important factor that controls the process of evapotranspiration. At a given location, air temperature is dependent on latitude and elevation, and it is also affected by the vegetative cover, soil type, and soil moisture.

In this report, the lowest and highest temperatures, occurring in a given month, are called the monthly minimum and maximum temperatures. The average of the two values is the monthly mean temperature.

Long-term, continuous records of temperature are available at the Big Trout Lake, Lansdowne House, and Lake Traverse meteorological stations. The other stations have short or discontinuous records. Since no long and concurrent records are available for all the stations, it was decided to conduct the water budget calculations separately for each basin and to make general comparisons of the results.

As indicated earlier, the relatively flat Canadian Shield provides a few barriers to the weather systems sweeping down from the north. As a result, the study area at times

experiences a variety of extreme weather events such as prolonged periods of extreme cold. As Table 1 indicates, the minimum monthly temperatures occur mainly during the period November to April, and the maximum monthly temperatures occur mainly during the period May to August.

Table 2 gives the mean monthly and annual temperatures recorded at the various meteorological stations. The areal variation of the mean monthly temperature within the study area can be described as the variations at the stations with long records (Big Trout Lake, Lansdowne House, and Lake Traverse). For this purpose, the temperatures for the months of January, April, June, and October can be selected as representatives of the four seasons. The mean monthly temperatures at the three selected stations in degrees Celsius are as follows:

Station Name	**January**	**April**	**June**	**October**
Big Trout Lake	-17.2 to -29.1	-7.2 to 1.5	7.9 to 15.4	-1.7 to 4.9
Lansdowne House	-15.3 to -26.7	-7.8 to 3.5	8.8 to 17.7	-0.6 to 9.0
Lake Traverse	-8.5 to -17.9	0.4 to 7.3	13.3 to 17.9	3.8 to 10.6

The minimum monthly temperature of -29.1 ^{0}C was recorded at Big Trout Lake during January and the maximum monthly temperature of 18.6 ^{0}C was recorded in July. The minimum monthly temperature of -26.8 ^{0}C was recorded at Lansdowne House in January and the maximum monthly temperature of 19.3 ^{0}C was recorded in July. The minimum monthly temperature of -17.9 ^{0}C was recorded at Lake Traverse in January and the maximum monthly temperature of 20.2 ^{0}C was recorded in July.

7.3 PRECIPITATION

Precipitation in the form of rain, snow, hail, frost or dew is the source of all water within a basin. Precipitation distribution usually varies from year to year and within the year primarily due to seasonal climatic factors. Often, precipitation is measured at one or more meteorological stations within a basin using precipitation gauges. Compared to streamflow, precipitation measurements are inferior in quality because they are made at single points within the basin. Measurements of streamflow, on the other hand, represent the total flow generated in a drainage area above the streamflow gauging station.

As indicated earlier, most precipitation falls in the form of showers and thunderstorms in the summer (June to September) and in the form of snow in the winter (October to May). Annual precipitation amounts increase from northwest to southeast - a reflection of the increasing influence of moisture transported from the Great Lakes and the Gulf of Mexico.

Table 1 gives the long-term mean monthly and annual precipitation data recorded at the seven meteorological stations within the study area. The table shows that the long-term mean annual precipitation values are as follows:

Meteorological Station	**Long-term Mean Annual Precipitation (mm)**
Big Trout Lake	586.8
Winisk	471.4
Lansdowne House	666.2
Fort Albany	539.2
Moosonee	746.6
Lake Traverse	796.6
New Liskeard.	675.5

Tables 3-9 give the monthly and annual precipitation and snowmelt for the seven meteorological stations. The areal variation of the monthly precipitation within the study area can be described as the monthly variations at the Big Trout Lake, Lansdowne House, and Lake Traverse stations. Table 3 gives the monthly and annual precipitation data for the period 1939 -1992 recorded at the Big Trout Lake station. The table shows that the lowest monthly precipitation values at this station occur during the months of December, January, February, March, and April. The months of February and March, however, show the lowest monthly values. During the 53 years of precipitation records at the Big Trout Lake station, the precipitation values for the months of February and March were the lowest 21times and 14 times, respectively.

Table 3 also shows that the highest monthly precipitation values recorded at the Big Trout Lake station occur during the months of June, July, August, and September. July and August, however, show the highest monthly values. During the 53 years of precipitation records at the Big Trout Lake station, precipitation values for the months of July and August were the highest 23 times and 12 times, respectively.

Table 5 gives the monthly and annual precipitation data recorded at the Lansdowne House station for the period 1941-1989. As for the Big Trout Lake station, Table 5 shows that the lowest monthly precipitation values occur during the months of December, January, February, March, and April. February and March also show the lowest monthly values. At the Lansdowne House station, the precipitation values for the months of February and March were the lowest 16 times and 13 times, respectively.

Table 5 also shows that the highest monthly precipitation values occur during the months of June, July, August, and September.The months of July and August show the highest monthly values. At the Lansdowne House station, the precipitation values for the months of July and August were the highest 16 times and 10 times, respectively.

Table 9 gives the monthly and annual precipitation data recorded at Lake Traverse station for the period 1965 -1986. Unlike the data for the other two stations that show greater differences between the low and high monthly values, the values at Lake Traverse station are of the same order of magnitude. Table 9 shows that the lowest monthly precipitation values occur in January, February, and March. January and February, however, show the lowest monthly values. At Lake Traverse station, the precipitation values for February and January were the lowest 10 times and four times, respectively.

Table 9 also shows that the highest monthly precipitation values occur during the months of June, July, August, and September. The highest monthly values, however, occur in July and August. The precipitation values for July and August the highest four times and five times, respectively.

7.4 SNOW

During the winter season a considerable part of precipitation falls in the form of snow in Ontario. Therefore, a complete description of the precipitation process for a basin in the province has to include by necessity information on snow measurement, accumulation and melt.

Snow is a deposit of ice crystals which has the capacity to accumulate on the ground surface for a considerable period of time under favorable climatic conditions. This capacity of the snow to accumulate influences for almost half of the year all the hydrologic processes that take place within any basin in Ontario, including the recharge to and the discharge from the groundwater storage. Freshly fallen snow usually has a density between 0.07 and 0.15 with an average of about 0.10 (Linsley et al.1958). It is a common practice in Canada to compute the water equivalent of newly fallen snow based on the assumption of a density of 0.10.

Special snow gauges are in operation at first order meteorological stations where the collected snowfall is melted down and its water equivalent is recorded. It is also common in hydrologic studies to establish a snow sampling network consisting of several snow courses. A standard snow course consists of ten sampling points distributed at regular intervals. The depths of snow, their water equivalents, and computed densities are recorded when the samples are collected at various points. Data on snow depth collected from the snow sampling network are usually used to verify the applied snowmelt procedure.

When assessing the snowfall within a basin, it is useful to:

– determine the total monthly and annual snowfall water equivalent at every precipitation gauge, and

– determine the percentage of the annual snowfall water equivalent in relation to the total annual precipitation at each station.

Table 1 indicates that data related to snowfall are available for the seven meteorological stations within the study area. Further, the table shows the following long-term means of annual snowfall:

Meteorologic Station	**Long-term Mean Annual Snowfall (mm)**
Big Trout Lake	191.4
Winisk	118.3
Lansdowne House	206.9
Fort Albany	118.5
Moosonee	234.7
Lake Traverse	226.7
New Liskeard.	212.8

The areal variations of the monthly snowfall within the study area can be described as the monthly variations at the Big Trout Lake, Lansdowne House, and Lake Traverse meteorological stations. Table 3 gives the monthly and annual snowfall data for the period 1939 -1992 recorded at the Big Trout Lake station. The table shows that the months of May, June, July, and August are snow free most of the time. Most of the snowfall at this station occurs in October to April. The months of November and December, however, show the highest snowfall values. At the Big Trout Lake station, the monthly snowfall values for November and December were the highest 20 and 10 times, respectively.

Table 5 gives the monthly and annual snowfall data for the period 1941 -1989 recorded at the Lansdowne House station. As at the Big Trout Lake station, the table shows that the months of May, June, July, and August are snow free most of the time. Most of the snowfall at this station occurs also in October to April. The months of November and December show the highest snowfall values. At this station, the monthly snowfall values for November and December were the highest 16 times and eight times, respectively.

Table 9 gives the monthly and annual snowfall data for the period 1965 -1986 recorded at the Lake Traverse station. The table shows that the months of May to October are snow free most of the time. Most of the snowfall at this station occurs during November to March, which reflects the southerly geographic location of the station. The months of November and January show the highest monthly values. At this station, the monthly snowfall values

for the months of December and January were the highest seven times and five times, respectively.

7.5 SNOWMELT

The generation of snowmelt at a point in a snowpack is essentially a thermodynamic process, the amount of the snowmelt produced being dependent on the net heat exchange between the snowpack and its environment (Gray 1970**)**. To account for the snowmelt, a number of complex and simple models have been developed.

The complex snowmelt models are based on the energy flux and mass transfer processes which occur across the snowpack-atmosphere interface, within the snowpack, and along the snowpack-ground surface interface. Usually, these models consider snow accumulation, evaporation, sublimation, and melt as separate but linked major processes in the simulation scheme. Unfortunately, it is extremely difficult to assemble all the required data to run such models. Missing data, which is a common problem in applied hydrology, necessitate the use of statistical techniques to fill in the missing data thus introducing errors into the process.

The simple snowmelt models make use of the widely available data related to daily temperature and rainfall. One such model is known in literature as the Degree-Day method. The method uses the daily average temperature (T) and the daily rainfall (R) as the only factors to estimate the daily snowmelt. In the Degree-Day method, the relationships between the amount of daily snowmelt (SM) and the daily average temperature and rainfall are assumed to be:

$$SM = M_t + Mr \qquad (3)$$

Equation 3 can be written also as:

$$SM = a * T + R * (T/80) \qquad (4)$$

where:

SM	=	total daily snowmelt (mm),
M_t	=	daily snowmelt caused by temperature (mm),
Mr	=	daily snowmelt caused by rain (mrn),
T	=	average daily temperature (^{0}C),
a	=	a constant equals to 3 mm/ 1^{0}C/day,
R	=	daily rainfall (mm),
80	=	the heat fusion of ice (cal /g).

When the average daily temperature (T) is below the freezing point (0 ^{0}C), precipitation is assumed to fall as snow and is added to the snowpack until melting conditions occur.

When (T) is above zero, the snowpack is assumed to release a daily amount of water (M_t) which is proportional to temperature according to the following relationship:

$$M_t = a * T \qquad (5)$$

The value assigned to the constant (a) can be adjusted, if necessary, by trial and error using the streamflow hydrographs corresponding to the snowmelt conditions.

When (T) is above zero, precipitation is assumed to fall as rain and the snowpack is assumed to release an additional amount of melt water (Mr) which is determined from the relationship:

$$Mr = R\,(T/80) \qquad (6)$$

Singer (1981) applied the snowmelt method described above to the Wilmot Creek basin which was investigated under the International Hydrologic Decade Program(1965-1974). The results for the season 1970-1971 were compared to those obtained by Logan (1975) who used a more elaborate model based on the net heat exchange between the snowpack and its environment to simulate the snowmelt in the same basin. Both methods gave identical results during the first 50 days of the simulation. Although the two methods gave different results later, both remained within one standard deviation from the average snowpack depth as measured at 12 snow courses in the Wilmot Creek basin. Based on the close agreement between the results of the Degree-Day method and the snowpack depths for other years in the same basin, Singer (1981) concluded that the method, despite its approximate nature, gives surprisingly good results. The simplicity of the method is a great advantage and the availability of the data (air temperature and rainfall) is an additional bonus.

The Degree-Day method was applied to the available daily temperature and precipitation records at the seven meteorological stations within the study area. Tables 3 to 9 show the monthly and annual snowmelt results for the various stations. The tables show the amounts of rainfall, snowfall, and liquid water (snowmelt and rain) that are available in each basin during each month and year. It is evident from the tables that the snowfall and snowmelt have a great modifying effect on the precipitation input.

Based on Tables 3 to 9, it is possible to conclude that precipitation within the study area during almost half of the year is locked in the snowpack. As a result, the amount of available liquid water in various basins on an annual basis could in some years be less than the precipitation input and in others more. Further, the liquid water during almost half of the year is not available as surface runoff or to recharge groundwater. During this time, streamflow is sustained by surface storage in various lakes and by groundwater discharge as baseflow.

The combined amount of rainfall and snowmelt within the study area during the months of November, December, January, February, and March is almost nil, and it is far less than the precipitation input. On the other hand, during the months of March, April and frequently May the sum of rainfall and snowmelt is much larger than the precipitation input. The large volume of water that is released during March, April, and May generates high flows and sometimes floods, and contributes substantially to the groundwater storage through infiltration. It is possible to state, therefore, that the major period of groundwater recharge within the study area coincides closely with the snowmelt period.

7. 6 POTENTIAL EVAPOTRANSPIRATION

Evapotranspiration is the combined evaporation from water, snow and soil surfaces and transpiration by vegetation. When the supply of water is not limiting, evapotranspiration occurs at the potential rate. If the water supply is limited, on the other hand, actual evapotranspiration will fall short of potential evapotranspiration.

Estimates of the monthly and annual potential evapotranspiration for seven basins within the study area were made by applying the method of Thornthwaite (Gray 1970). The method employs an empirical equation which relates the potential evapotranspiration to the mean air temperature and it includes a latitude adjustment factor for various months. This method was selected because of the availability of daily temperature data and the lack of more detailed climatological data that are required by other methods. The Thornthwaite method uses the following equation to estimate the potential evapotranspiration within an area:

$$PET = 1.6\,[10T_m / I\,]^a \qquad (7)$$

where

PET = potential evapotranspiration (cm/month)
T = mean monthly air temperature (^{0}C)
I = annual heat index
a = $0.49 + 0.0179\,I - 0.0000771\,I^2 + 0.000000675\,I^3$

The mean monthly temperatures as measured at the seven meteorological stations were assumed to represent the temperature in the corresponding seven basins within the study area, and they were used to obtain the monthly estimates of potential evapotranspiration. The calculated values were then adjusted to reflect the number of days per month and the length of each day which is a function of latitude. The correction factors used in the calculation of the monthly and annual evapotranspiration values were for Latitudes 46 ^{0}N, 48 ^{0}N, 50 ^{0}N, 52 ^{0}N, 53 ^{0}N, 54 ^{0}N, and 55 ^{0}N (Gray 1970).

Table 1 gives the long-term monthly and annual means of potential evapotranspiration for the seven meteorological stations. The table shows that the annual long-term means for potential evapotranspiration are as follows:

Meteorologic Station	**Long-term Mean Annual Potential Evapotranspiration (mm)**
Big Trout Lake	445.0
Winisk	384.5
Lansdowne House	470.1
Fort Albany	447.1
Moosonee	461.1
Lake Traverse	513.2
New Liskeard	539.9

The increase in the long-term annual values from Big Trout Lake station to Lake Traverse station reflects the decrease in geographic latitude and the corresponding increase in the mean annual temperature. Table 1 also shows that those long-term monthly values for potential evapotranspiration are almost nil from November to May. The values become substantial during the period June to October. The highest values, however, occur during June, July, and August. The monthly and annual values of potential evapotranspiration for the seven meteorological stations are given in Tables 10 to 16.

7.7 ACTUAL EVAPOTRANSPIRATION

As indicated earlier, if the water supply within an area is limited, actual evapotranspiration will fall short of the potential evapotranspiration. In addition, the rate of actual evapotranspiration will depend on the feasibility to draw water from the soil column. From a hydrological point of view, the soil acts as a water reservoir and at any time there is some water in the soil referred to as the soil moisture storage. Water in the soil can be classified as:

- Hygroscopic water which is that part of the soil moisture that is absorbed from the atmosphere as a thin film on the surface of soil particles. It is held with considerable force and it is not available to plants.

- Capillary water which is that part of the soil moisture that is held by surface tension in the capillary spaces and as a continuous film around the particles.

It is free to move under the influence of capillary forces and it is available to plants.

– Gravitational water which is that part of the soil moisture that drains through the soil under the influence of gravity (Linsley et al. 1958).

Two concepts are often used with regard to soil moisture, the field capacity and the wilting point. The field capacity is the amount of moisture remaining in the soil after the gravity water has been allowed to drain away, usually expressed as a percentage of the oven-dry weight of soil. The wilting point, on the other hand, is the moisture content of the soil, on an oven-dry basis, at which plants wilt and fail to recover their turgidity when placed in a dark humid atmosphere. Recently, the terms “field capacity” and “wilting point” are being phased out. Instead, the terms “wet limit” and “dry limit” are used. These two limits are given as percentages of the volumetric moisture content at 0.33 and 15-bar, respectively. The quantity of water a soil can retain in a form available to plants is between the limits 0.33-bar percentage, which is the wet limit, and the 15-bar percentage, which is the dry limit.

In Ontario, it is possible to assume that the soils within an area are at the wet limit in the spring because the water supply is ample in the form of rain and snowmelt. It is also possible to assume that the soils are at the wet limit in the late fall and winter because the process of evapotranspiration during this time is minimal due to cold temperatures and dormant plants. By contrast, soils approach the dry limit during the summer months when much of the precipitation is returned to the atmosphere as evapotranspiration or used to satisfy soil moisture deficits.

The monthly liquid water calculated for the various meteorological stations were used as input to the Moisture Budget Technique method (Holmes and Robertson 1960) to arrive at the actual monthly evapotranspiration values for seven basins within the study area. In order to carry out the analysis, two additional types of data were required:

– an estimate of the initial soil moisture storage values for the first month to be analyzed, and

– an estimate of the soil moisture capacity for the gauged area.

It was assumed that the initial soil moisture storage for each basin within the study area to be equal to its wet limit for the month of January which is the first month to be analyzed. Because of the lack of soil maps for the study area, and in order to estimate the soil moisture capacity for the basins, the areas of various geologic formations (bedrock, till, sand, and clay) were calculated and their areal weights were determined. Further, the soil moisture capacities for the various soils developed on these parent materials were assumed to be as follows:

Parent Material	Soil Moisture Capacity (mm)
Bedrock	25
Sand and Gravel	100
Till	125
Clay	180

The low value that was assigned to the bedrock reflects the fact that the soil developed on the Canadian Shield is shallow or missing. The actual monthly evapotranspiration was calculated for various geologic areas. The weights of the various areas were then used to arrive at estimates of the monthly and annual actual evapotranspiration for each basin.

Table 1 gives the long-term monthly and annual means of actual evapotranspiration for the various meteorological stations. The table shows that the annual long-term means for actual evapotranspiration are as follows:

Meteorologic Station	Long-term Mean Annual Actual Evapotranspiration (mm)
Big Trout Lake	397.7
Winisk	368.6
Lansdowne House	430.1
Fort Albany	353.7
Moosonee	431.1
Lake Traverse	417.4
New Liskeard.	453.9

Again, the increase in the long-term annual values from Big Trout Lake station to Lake Traverse station reflects the decrease in geographic latitude and the corresponding increase average temperature. Table 1 also shows that the long-term monthly values for actual evapotranspiration are almost nil from November to May. These values become substantial during the period June to October. The highest values, however, occur during June, July, and August. The monthly and annual values of actual evapotranspiration for the seven meteorological stations are given in Tables 10 to 16.

7.8 SURFACE WATER

Surface water is generally defined as water that occurs on the land surface, including water in streams, ponds, lakes, swamps and drainage ditches. Historically, surface water has always been an important source of water supply because of its availability and accessibility. If maximum use is to be made of the resource, however, it is essential to know its quality, quantity, and distribution.

Continuous, daily flow records are available at many gauging stations within the study area. Some of these records are short consisting of a few years while others are long-term and contain more than 50 years of records. Appendix III gives of the names and geographic locations of all the streamflow gauging stations in northern Ontario. There are 10 gauging stations within the Severn River basin, nine stations in the Winisk River basin, six stations in the Attawapiskat River basin, 27 stations in the Albany River basin, 31 stations in the Albany River basin, and 37 stations in the Upper Ottawa River basin.

As indicated earlier, seven basins have been selected in order to assess the water resources within the study area and conduct water budget calculations. To facilitate the calculations, an effort was made to ensure that the selected gauging stations are located as close as possible to the mouths of the selected basins. To this end, the following stations were selected:

Basin:	Severn River
Station Name:	Severn River at Limestone Rapids
Station Number:	04CC001
Drainage Area:	87,472.85 km^2
Period of Records:	1970 -1992

Basin:	Winisk River
Station Name:	Winisk River below Asheweig River Tributary
Station Number:	04DC001
Drainage Area:	50,921.53 km^2
Period of Records:	1966 -1994

Basin:	Attawapiskat River
Station Name:	Attawapiskat River below Muketei River
Station Number:	04FC001
Drainage Area:	37,455.64 km^2
Period of Records:	1968 -1995

Basin:	Albany River
Station Name:	Albany River near Hat Island
Station Number:	04HA001
Drainage Area:	112,037.82 km^2
Period of Records:	1984 -1989

Basin:	Moose River
Station Name:	Moose River above Moose River
Station Number:	04LG004
Drainage Area:	61,725.57 km^2
Period of Records:	1983 -1996

Basin: Montreal River
Station Name: Montreal River at Lower Notch Generating Station
Station Number: 02JD010
Drainage Area: 6,435.48 km^2
Period of Records: 1972 -1984

Basin: Petawawa River
Station Name: Petawawa River at Petawawa
Station Number: 02KB001
Drainage Area: 4,070.13 km^2
Period of Records: 1965 -1996.

A comprehensive information about river flows requires data collection over a long period of time, preferably on a continuous basin. The above information indicates that the streamflow data are not concurrent. Further, the data range in length from about six years for the Albany River basin to 31 years for the Petawawa River basin. Unfortunately, the lack of long continuous records results in an incomplete understanding of the water resources of the study area.

7.8.1 Variation of Annual and Monthly Flows

An examination of the available data at all the stations (Tables 17-23) shows that the flows are highest during the spring melting season between May and June and sometimes April. Unlike river flows in southern Ontario, however, where the lowest flows occur in the summer and fall, the lowest flows within the Severn, Winisk, Attawapiskat, Albany, and Moose River basins occur mainly in January, February, March, and April. This is because extremely low temperatures in the winter cause precipitation to be stored as snow which inhibits surface runoff. River flow in these basins during the fall and winter seasons is mainly from water stored in lakes and groundwater discharge. Compared to river flows in northern and southern Ontario, flows in the Montreal and Petawawa Rivers show transitional characteristics. The highest flows in these two basins are observed mainly during April and May, but the low flows occur during the summer and fall.

The annual flow values at the Limestone Rapids gauging station on the Severn River range from 127.2 mm (352.8 m^3/s) measured in 1991 to 348.4 mm (966.5 m^3/s) measured in 1975. The mean annual flow at this station is 228.2 mm (633.1 m^3/s). The 20-year high flow, which is the average daily flow that will be exceeded, on average, once in 20 years of record, was estimated to be 1,232.8 mm (3,420.0 m^3/s). The 20 year-7day low flow, which is the average flow over the period of seven consecutive days that will be exceeded, on average, in 19 out of 20 years of record, was estimated to be 33.5 mm (93.0 m^3/s). The

highest monthly flow of 69.6 mm (192.8 m^3/s) was recorded in June1985 and the lowest monthly flow of 2.9 mm (8.0 m^3/s) was recorded in March 1977.

The annual flow values at the Winisk gauging station on the Winisk River range from 126.4 mm (203.5 m^3/s) measured in 1990 to 509.0 mm (819.5 m^3/s) measured in 1985. The mean annual flow at this station is 266.9 mm (429.7 m^3/s). The 20-year high flow was estimated to be 1,478.3 mm (2,380.0 m^3/s). The 20 year-7day low flow was estimated to be 31.5 mm (50.0 m^3/s). The highest monthly flow of 126.4 mm (203.5 m^3/s) was recorded in June1985 and the lowest monthly flow of 1.5 mm (2.4 m^3/s) was recorded in September 1978.

More than 27 years of flow data (1968 -1994) are available for the Attawapiskat River at the gauging station located below the confluence with the Muketei River. The annual flows at this station range from 155.0 mm (182.9 m^3/s) measured in 1993 to 475.2 mm (560.7 m^3/s) measured in 1985. The mean annual flow at the station is 302.6 mm (357.1 m^3/s), the 20-year high flow is 2,737.3 mm (3,230.0 m^3/s), and the 20 year-7day low flow is 37.3 mm (44.0 m^3/s). The highest monthly flow of 81.6 mm (69.1 m^3/s) was recorded in June1985 and the lowest monthly flow of 3.3 mm (2.8 m^3/s) was recorded in March1977.

Six years of flow data (1984 -1989) are available for the Albany River at the gauging station located near Hat Island. By comparing these data to those collected in neighboring basins, it is possible to conclude that the data are mostly below average. The annual flows at the gauging station range from 163.1 mm (579.0 m^3/s) measured in 1987 to 403.5 mm (1,432.4 m^3/s) measured in 1985. The mean annual flow for the six years is 247.1 mm (877.1 m^3/s). The highest monthly flow of 84.8 mm (301.0 m^3/s) was recorded in May 1989 and the lowest monthly flow of 2.7 mm (9.6 m^3/s) was recorded in March 1987.

Fourteen years of flow data (1983 -1996) are available for the Moose River at the gauging station located west of Moosonee. The annual flows at this station range from 261.6 mm (512.7m^3/s) measured in 1987 to 495.8 mm (971.8 m^3/s) measured in 1990. The mean annual flow at the station is 380.5 mm (745.8 m^3/s), the 20-year high flow was estimated to be 3,795.9 mm (7,440.0 m^3/s), and the 20 year-7day low flow was estimated to be 42.8 mm (84.0 m^3/s). The highest monthly flow of 228.8 mm (448.4 m^3/s) was recorded in May 1996 and the lowest monthly flow of 7.1 mm (13.9 m^3/s) was recorded in January 1994.

Thirteen years of flow data (1972 -1984) are available for the Montreal River at the gauging station located at the Lower Notch Generating Station. The annual flows at this station range from 291.7 mm (58.3 m^3/s) measured in 1982 to 540.6 mm (108.1 m^3/s) measured in 1979. The mean annual flow at the station is 373.6 mm (74.7 m^3/s). The highest monthly flow of 2,242 mm (448.4 m^3/s) was recorded in May 1979 and the lowest monthly flow of 4.6 mm (13.9 m^3/s) was recorded in August 1982.

Thirty two years of flow data (1965 -1996) are available for the Petawawa River at the gauging station located at Petawawa. The annual flows at this station range from 234.6 mm (30.3 m^3/s) measured in 1987 to 541.7 mm (69.9 m^3/s) measured in 1972. The mean annual flow at the station is 391.2 mm (50.5 m^3/s). The highest monthly flow of 160.1 mm (20.6 m^3/s) was recorded in May 1972 and the lowest monthly flow of 4.0 mm (0.5 m^3/s) was recorded in September 1989.

7.8.2 Flow Duration Analysis

A flow duration curve is a cumulative frequency curve that shows the percentage of time specified flows are equaled or exceeded during a given period. It combines in one curve the flow characteristics of a river throughout its range of discharge and period of record without regard to the sequence of flow events. A flow-duration curve is prepared by arranging the daily flow data for a gauging station according to magnitude, and computing the percentage of time over the total period during which flows equaled or exceeded specified values.

The flow duration curve is one method of showing flow variability. It can be a useful characteristic of a drainage area and it is used in comparisons between the flow characteristics of rivers or reaches of rivers. The curve has application, especially when based upon a long period of record, in predicting the distribution of future flows and, as such, it is useful in the study of water-supply problems, power developments, and dilution and disposal of sewage and industrial waste materials.

Shapes of the flow duration curves are influenced by the geologic and hydrologic characteristics of drainage basins and they provide clues about the natural water storage in these basins. A curve that is nearly horizontal indicates a more permeable basin with relatively larger groundwater storage capacity and a greater role of groundwater discharge in sustaining the river's flow (Singer 1981). The effects of groundwater discharge on flow are usually reflected in the lower section of the flow duration curve. Under normal runoff conditions, without interference due to temporary storage or permanent water withdrawal, the slope of the lower section of the flow duration curve show if the river has stable baseflow conditions (Singer 1981).

Figure 29 shows a comparison between the flow duration curves at the seven gauging stations within the study area. The figure indicates that the flow duration curve for the Montreal River at station 02JD010 breaks at the 95% exceedence level which could be due to the fact that the flow is regulated. The other curves, on the other hand, have similar shapes without any breaks.

Walton (1965) suggested using the ratio $(Q_{25}/Q_{75})^{½}$, which describes the slope of the flow duration curve, as a quantitative index of the role groundwater plays in river flow. The terms in the above ratio are as follows:

- Q_{25} is the flow equaled or exceeded 25% of the time, and
- Q_{75} is the flow equaled or exceeded 75% of the time.

The following ratios were obtained for the seven gauging stations within the study area:

Basin	**Station**	**Ratio $(Q_{25}/Q_{75})^{½}$**
Severn	04CC001	1.85
Winisk	04DC001	2.00
Attawapiskat	04FC001	2.19
Albany	04HA001	2.23
Moose	04LG004	1.73
Montreal	02JD010	1.89
Petawawa	02KB001	1.92

According to Walton (1965), basins with small ratios have larger groundwater components. The Moose, Severn, Montreal, and Petawawa River basins have the smallest ratios, which probably reflects the abundance of sands and gravels in these basins.

7.8.3 Flow Separation and Groundwater Discharge

It is generally recognized that river flow consists of the following three components:

- direct runoff, which is that part of precipitation that flows over the land surface to the rivers;

- inter-flow, which is that part of precipitation that flows part of the way underground, but does not become part of the groundwater regime;

- baseflow, which is that part of the precipitation that reaches the rivers as natural groundwater discharge, after being a part of the groundwater regime.

Wang and Chin (1978) used the 95% exceedence levels on the flow duration curves for five major rivers within the study area to estimate directly the groundwater discharge to these rivers. Based on this approach, the following results were reported:

Basin	Groundwater Discharge as % of Surface Runoff
Severn	19
Winisk	20
Attawapiskat	8
Albany	27
Moose	34

One way to estimate the groundwater discharge is to separate the flow into different components. Unfortunately, the principles of separating the flow into components are not well developed, and in the case of complex precipitation and snowmelt events, flow separation appears to be somewhat arbitrary. It is believed, however, that if a certain procedure of flow separation is followed consistently, the same errors will be committed systematically and, therefore, useful results can be obtained for comparison purposes.

Given that the river basins within the study are extremely large in size and contain numerous lakes and wetlands that act as natural reservoirs, the results of flow separation techniques applied to such basins are suspect. To have an appreciation of the magnitude of groundwater contribution to these rivers, however, it was decided to separate the flows in a few small watersheds.

For the purpose of this study, a flow separation computer program was applied. The program is based on a procedure which separates the flow into two components, a surface runoff component consisting of direct runoff and inter-flow, and a baseflow component. The program allows for the processing of a large amount of data in a very short time and ensures consistency in the application. Six parameters are used in the program. The first parameter is to detect the beginning of an event, the second is to determine the event period, the third is to detect the peak flow, the fourth is to determine the value of the groundwater component under the peak, the fifth is to determine the relative event limits, and the sixth is to determine the absolute event limit.

As indicated above, a few small watersheds were selected in various rive basins to appreciate the magnitude of groundwater discharge into the major rivers within the study area. To this end, the following eleven gauging stations were selected:

Basin	Station No.	Location	Period of Records
Severn	04CA003	Roseberry River above Roseberry Lakes	(1967-1992)
Winisk	04DA001	Pipestone River at Karl Lake	(1966-1996)
	04DB001	Asheweig River at Straight Lake	(1966-1994)

Attawapiskat	04FA002	Kawinogans River near Pickle Crow	(1967-1993)
	04FA003	Pineimuta River at Eyes Lake	(1966-1994)
Albany	04JC003	Shekak River at Highway No. 11	(1952-1986)
	04GB004	Ogoki River above Whiteclay Lake	(1971-1996)
Moose	04LA002	Mattagami River near Timmins	(1974-1996)
	04LJ001	Missinaibi River at Mattice	(1920-1996)
Upper Ottawa	02JD004	Montreal River at Elk Lake	(1938-1957)
	02JD008	Montreal River at Upper Notch Generating Station	(1931-1971)

The flow separation results for station 04CA003 on the Roseberry River (Table 24) indicate that the total annual groundwater contributions range from 22.6 to 78.7 mm with a long-term annual mean of 48.4 mm. This is equivalent to 13.8% and 21.2% of the corresponding annual surface runoff and to 17.8% of the long-term annual runoff. The smallest groundwater contributions occur in November to March and the largest contributions occur in May and June. The long-term monthly groundwater contributions range from 1.9 mm for February to 9.0 mm for May.

The flow separation results for station 04DA001 on the Pipestone River (Table 25) indicate that the total annual groundwater contributions range from 40.0 to 120.9 mm with a long-term annual mean of 76.4 mm. This is equivalent to 22.5% to 24.4% of the corresponding annual surface runoff and to 25.7% of the long-term annual runoff. The smallest groundwater contributions occur in November to March and the largest contributions occur in May to July. The long-term monthly groundwater contributions range from 4.2 mm for March to 10.2 mm for May.

The flow separation results for station 04DB001 on the Asheweig River (Table 26) indicate that the total annual groundwater contributions range from 51.5 to 107.0 mm with a long-term annual mean of 73.6 mm. This is equivalent to 31.1% and 20.3% of the corresponding annual surface runoff and to 24.4% of the long-term annual runoff. The smallest groundwater contributions occur in November to April and the largest contributions occur in of May to July. The long-term monthly groundwater contributions range from 5.3 mm for April to 7.5 mm for May.

The flow separation results for station 04FA002 on the Kawinogans River (Table 27) indicate that the total annual groundwater contributions range from 51.7 to 136.1 mm with a long-term annual mean of 84.6 mm. This is equivalent to 39.9% and 25.8% of the corresponding annual surface runoff and to 26.9% of the long-term annual runoff. The smallest groundwater contributions occur in November to April and the largest contributions

occur in May to July. The long-term monthly groundwater contributions range from 5.5 mm for February to 9.9 mm for May.

The flow separation results for station 04FA002 on the Pineimuta River (Table 28) indicate that the total annual groundwater contributions range from 49.4 to 119.9 mm with a long-term annual mean of 78.9 mm. This is equivalent to 25.3% and 26.5% of the corresponding annual surface runoff and to 23.4% of the long-term annual runoff. The smallest groundwater contributions occur in November to April and the largest contributions occur in May to July. The long-term monthly groundwater contributions range from 3.7 mm for March to 11.6 mm for May.

The flow separation results for station 04JC003 on the Shekak River (Table 29) indicate that the total annual groundwater contributions range from 49.7 to 109.6 mm with a long-term annual mean of 77.7 mm. This is equivalent to 20.1% and 27.2% of the corresponding annual surface runoff and to 22.4% of the long-term annual runoff. The smallest groundwater contributions occur in August to March and the largest contributions occur in May and June. The long-term monthly groundwater contributions range from 4.0 mm for September to 13.5 mm for May.

The flow separation results for station 04GB004 on the Ogoki River (Table 30) indicate that the total annual groundwater contributions range from 63.7 to 155.3 mm with a long-term annual mean of 91.4 mm. This is equivalent to 42.5% and 58.9% of the corresponding annual surface runoff and to 31.7% of the long-term annual runoff. The smallest groundwater contributions occur in November to April and the largest contributions occur in May to July. The long-term monthly groundwater contributions range from 6.5 mm for February to 9.2 mm for May.

The flow separation results for station 04LA002 on the Mattagami River (Table 31) indicate that the total annual groundwater contributions range from 80.7 to129.2 mm with a long-term annual mean of 109.5 mm. This is equivalent to 28.8% and 37.6% of the corresponding annual surface runoff and to 30.4% of the long-term annual runoff. The smallest groundwater contributions occur in September to February and the largest contributions occur in April to July. The long-term monthly groundwater contributions range from 8.1 mm for September to 14.4 mm for May.

The flow separation results for station 04LJ001 on the Missinaibi River (Table 32) indicate that the total annual groundwater contributions range from 50.5 to109.5 mm with a long-term annual mean of 115.3 mm. This is equivalent to 24.8% and 27.1% of the corresponding annual surface runoff and to 21.4% of the long-term annual runoff. The smallest groundwater contributions occur in August to March and the largest contributions occur in April to June. The long-term monthly groundwater contributions range from 3.19 mm for August to 19.2 mm for May.

The flow separation results for station 02JD004 on the Montreal River at Elk Lake (Table 33) indicate that the total annual groundwater contributions from 80.9 to183.2 mm with a long-term annual mean of 124.7 mm. This is equivalent to 31.3% and 46.31% of the corresponding annual surface runoff and to 34.7% of the long-term annual runoff. The smallest groundwater contributions occur in August to March and the largest contributions occur in April to June. The long-term monthly groundwater contributions range from 8.5 mm for September to 15.4 mm for May.

Only the natural flows for station 02JD008 on the Montreal River at the Upper Notch Generating Station were considered for analysis (Table 34). The flow separation results for the station indicate that the total annual groundwater contributions range from 105.0 to148.1 mm with a long-term annual mean of 126.9 mm. This is equivalent to 29.2% and 26.9% of the corresponding annual surface runoff and to 31.9% of the long-term annual runoff. The smallest groundwater contributions occur in August to March and the largest contributions occur in April to June. The long-term monthly groundwater contributions range from 7.4 mm for February to 14.2 mm for May.

The results of the streamflow analyses indicate that the groundwater contributions to the various small watersheds within the study area vary from one watershed to another and from one basin to another on a daily, monthly, annual, and long-term basis. This reflects variations in the geologic and climatic conditions within these watersheds.

When daily flow records in excess of 10 years are available at a given gauging station, they would allow for the determination of the long-term monthly and annual groundwater discharge at that station. At a given gauging station with more than 10 years of records, the sum of cumulative changes in soil moisture storage approaches zero. Given this fact, it is possible to assume that the long-term means of annual groundwater discharge, calculated for such a station, are approximately equal to the corresponding long-term means of annual groundwater recharge. By applying this concept, the long-term annual means of groundwater recharge within the above small watersheds are as follows:

Station No.	Long-term Annual Groundwater Recharge (mm)	% of Long-term Annual Runoff
04CA003	48.4	17.8
04DA001	76.4	25.7
04DB001	73.6	24.4
04FA002	84.6	26.9
04FA003	78.9	23.4
04JC003	77.6	22.4

04GB004	91.4	31.7
04LA002	109.5	30.4
04LJ001	78.7	21.4
02JD004	124.7	34.7
02JD008	126.9	31.9

The above groundwater recharge estimates for the small watersheds are probably much larger than amounts of recharge to the larger basins. This is because vast portions of the basins that contain these watersheds are covered with materials with low infiltration rates.

7.8.4 Soil Moisture and Groundwater Recharge

Groundwater recharge is the flux of water from the unsaturated zone into the groundwater zone. Factors affecting the recharge process are the status of moisture within the soil, the topographic characteristics of the area, the vertical permeability of the overburden deposits, and the intensity and distribution of the fracture systems in the bedrock.

Precipitation is the primary source of water for the replenishment of soil moisture. Lateral transfer of water over the ground surface from topographic highs to lows and the upward flow of water from the groundwater zone to the unsaturated zone provide further sources of replenishment to the soil moisture. The primary mechanisms for soil moisture depletion are through evapotranspiration and gravity drainage. The magnitude of evapotranspiration is controlled by the soil moisture availability and the climatic conditions. Gravity drainage, on the other hand, occurs in response to pressure gradients either vertically or laterally. Whereas the lateral movement of the soil moisture generates inter-flow, its downward vertical movement contributes to the recharge of groundwater (Singer 1981).

Provided that there is no gain to the groundwater storage from outside areas, the recharge within a basin is completely controlled by the status of soil moisture. Except in river valleys that constitute the main discharge zones, groundwater recharge occurs almost everywhere else in the basin. The rate of recharge, however, is very high in certain areas and the identification of such areas is very important for the appropriate management of groundwater resources of the basin.

Measurements of static water level variations at observation wells are the best means to determine the periods of groundwater recharge. Wang and Chin (1978) summarized the measurements of the water level fluctuations in four bedrock wells and 36 overburden wells during the period 1968 to 1973 in the areas draining into Hudson Bay and James Bay. The authors also included the hydrographs of five observation wells in the area. Although the hydrographs are incomplete, they show a rise in water levels mainly during the month of

May and a decline during the period November to March. The water levels in these wells fluctuated between 0.3 and 1.8 m with an average value of 0.7 m. Based on these fluctuations, Wang and Chin (1978) estimated the annual changes in groundwater storage to be about 20 million cubic meters, of which less than 0.5% occurs in the bedrock units.

When discussing the recharge process, it is important to keep in mind that the groundwater storage is continually being depleted by discharge to streams. Therefore, when the static water level remains constant in the well, the amounts of recharge and discharge are equal. A rise in the static level indicates that recharge exceeds discharge; a fall indicates that the reverse is true.

Groundwater recharge occurs at a maximum rate when the soil is in a state of complete saturation and it diminishes when the soil is at the dry limit. In northern Ontario, this condition is met mainly during the snowmelt and spring rainfall events which usually extends from May through June and early July. During this period, temperatures start to rise, the soil moisture is close to saturation, and evapotranspiration is low. The snowpack starts to deplete until it vanishes completely and a vast amount of liquid water, produced by melting snow and rainfall events, is suddenly available. Part of this water generates high flows and floods. The remaining water infiltrates through the soil and then percolates to the groundwater storage. This is the period of the major groundwater recharge in northern Ontario when the water table reaches a maximum height and the groundwater storage is at its peak.

During the summer and early fall, the soil moisture is utilized mainly by plants through evapotranspiration and a state of soil moisture deficiency usually prevails. Therefore, most of the infiltrated water from the rain, during this period, is used to satisfy this deficiency with little or no water left to recharge groundwater. As a result, groundwater levels steadily decline except during heavy rainfall events. Precipitation during November to April is mainly in the form of snow and it is not available for recharge. Most of the decline in groundwater levels occurs, therefore, from November to April.

7.8.5 Long-term Annual Groundwater Recharge and Discharge

Estimates of the long-term of groundwater recharge can be made using water balance calculations, streamflow separation techniques, measurements of hydraulic potentials, chemical tracers such as salt and dyes, radioisotopes, or anthropogenic traces.

Chin and Wang (1978) assumed that the mean annual groundwater recharge within the Severn, Winisk, Attawapiskat, Albany, and Moose River basins to be equal to the daily streamflow that is equaled or exceeded 90% of the time in these basins. Based on this assumption, Chin and Wang (1978) estimated the mean annual groundwater recharge to be 68.6 mm over the five basins.

One way to estimate the long-term groundwater recharge is to consider the type and areal extent of various geologic formations within the study area and assign to these formations a range of recharge rates based on published studies. According to Singer (1981), the annual recharge in areas covered by sands and gravels ranges from 300.0 to 350.0 mm per year, in areas covered by sandy till it ranges from 50.0 to 75.0 mm per year, and in areas covered by clay till it ranges from 25.0 to 50.0 mm per year. Thorne and Gascoyne (1993) reported estimates of groundwater recharge in granitic areas in Canada . The estimates of of groundwater recharge in these areas were less than 5.0 mm/year. For the purposes of this study, the ranges of annual recharge to various geologic deposits were assumed as follows:

Geologic Deposit	Annual Range of Recharge (mm)
Precambrian rocks	3 - 5
Paleozoic rocks	25 - 50
Silty clay till	1 0 - 25
Sand to silty sand till	50 - 75
Silt and clay	5 - 10
Peat, muck, and marl	2 - 5
Sands and gravels	300 - 350

The areal extent and percentages of the above geologic deposits within the study area and its six major basins were computed using GIS techniques. Based on these calculations, the ranges of the long-term annual groundwater recharge were determined.

The Long-term annual groundwater recharge in the *Severn River drainage basin* was estimated as follows:

Geologic Deposit	% of Basin Area	Contribution to Recharge (mm)
Precambrian	35.96	1.1 - 1.8
Silty clay till	3.75	0.4 - 0.9
Sand to silty sand till	17.85	8.9 - 13.4
Silt and Clay	6.61	0.3 - 0.7
Sand and Gravel	5.45	16.4 - 19.1
Peat, muck and marl	25.95	0.5 - 1.3
Open water	4.43	-------------
Range of Long-term Annual Recharge:		27.6 - 37.2

The Long-term annual groundwater recharge in the *Winisk River drainage basin* was estimated as follows:

Geologic Deposit	**% of Basin Area**	**Contribution to Recharge (mm)**
Precambrian	15.81	0.5 - 0.8
Silty clay till	2.56	0.3 - 0.6
Sand to silty sand till	30.73	15.4 - 23.0
Silt and Clay	0.56	0.0 - 0.1
Sand and Gravel	4.46	13.4 -15.6
Peat, muck and marl	43.19	0.9 - 2.2
Open water	2.69	-------------
Range of Long-term Annual Recharge:		30.5 - 42.3

The Long-term annual groundwater recharge in the Attawapiskat *River drainage basin* was estimated as follows:

Geologic Deposit	**% of Basin Area**	**Contribution to recharge (mm)**
Precambrian	9.95	0.3 - 0.5
Silty clay till	3.69	0.4 - 0.9
Sand to silty sand till	19.52	9.8 - 14.6
Silt and Clay	2.76	0.1 - 0.3
Sand and Gravel	6.4	19.2 - 22.4
Peat, muck and marl	56.05	0.5 - 1.3
Open water	1.65	-------------
Range of Long-term Annual Recharge:		30.3 - 40.0

The Long-term annual groundwater recharge in the *Albany River drainage basin* was estimated as follows:

Geologic Deposit	**% of Basin Area**	**Contribution to Recharge (mm)**
Precambrian	28.55	0.9 - 1.4
Silty clay till	4.39	0.4 - 1.1

Sand to silty sand till	12.45	6.2 - 9.3
Silt and Clay	3.38	0.2 - 0.3
Sand and Gravel	11.83	35.5 - 41.4
Peat, muck and marl	35.52	0.5 - 1.3
Open water	3.74	-------------

Range of Long-term Annual Recharge: 43.7- 54.8

The Long-term annual groundwater recharge in the Moose *River drainage basin* was estimated as follows:

Geologic Deposit	**% of Basin Area**	**Contribution to Recharge (mm)**
Precambrian	25.68	0.8 - 1.3
Silty clay till	21.71	2.2 - 5.4
Sand to silty sand till	2.54	1.3 - 1.9
Silt and Clay	13.99	0.7 - 1.4
Sand and Gravel	13.38	40.1 - 46.8
Peat, muck and marl	21.71	0.4 - 1.1
Open water	1.00	-------------

Range of Long-term Annual Recharge: 45.5 - 57.9

The Long-term annual groundwater recharge in the *Upper Ottawa River drainage basin* was estimated as follows:

Geologic Deposit	**% of Basin Area**	**Contribution to Recharge (mm)**
Precambrian	54.92	1.6 - 2.7
Paleozoic rocks	0.16	0.0 - 0.1
Sand to silty sand till	11.08	5.5 - 8.3
Silt and Clay	9.79	0.5 - 1.0
Sand and Gravel	20.16	60.5 - 70.57
Peat, muck and marl	2.22	0.0 - 0.1
Open water	1.66	-------------

Range of Long-term Annual Recharge: 68.1 - 82.8

The Long-term annual groundwater recharge for the whole study area was estimated as follows:

Geologic Deposit	% of Basin Area	Contribution to Recharge (mm)
Precambrian	21.92	0.7 - 1.1
Paleozoic	0.01	0.0 - 0.01
Silty clay till	6.68	0.7 - 1.7
Sand to silty sand till	12.51	6.2 - 9.4
Silt and Clay	4.87	0.2 - 0.5
Sand and Gravel	8.30	24.9 -29.1
Peat, muck and marl	43.37	0.9 - 2.2
Open water	2.34	-------------
Range of Long-term Annual Recharge:		33.6 - 44.0

The above estimates for the long-term annual groundwater recharge represent also the long-term annual discharge. Thees estimates can be presented as follow:

Basin	Long-term Annual Recharge/ Discharge m^3/s	% of Long-term Annual Flow
Severn	80.0 - 107.9	12.1 - 16.3
Winisk	66.4 - 92.1	17.4 - 24.2
Attawapiskat	55.2 - 72.9	10.0 - 13.2
Albany	190.1 - 228.4	17.7 - 22.2
Moose	139.7 - 177.8	11.9 - 15.2
Upper Ottawa	59.2 - 72.0	
Total Study Area	658.6 - 862.4	

As indicated earlier, groundwater recharge can occur anywhere within a basin. From a practical point of view, however, the most important groundwater recharge areas are those where high permeable materials are at the surface. In the case of the study area, most of the groundwater recharge occurs where sands and gravels deposits of glaciofluvial, glaciolacustrine and glaciomarine origin outcrop at the surface.

7.8.6 Results of the Water Budget Calculations

As indicated earlier, the calculation of the annual water budget for a basin provides a summary of the hydrologic cycle for the basin. When possible, the calculation should consider the amount of precipitation that falls on the basin, the amount of water that is stored in the snowpack, the combined snowmelt and rain input. It should also consider the amount of water that is returned back to the atmosphere through actual evapotranspiration, the amount of water that becomes surface runoff, the amount of water that becomes baseflow (groundwater discharge), and the changes that occur within the soil moisture storage and the groundwater storage.

The calculation of the annual water budgets for seven basins within the study area are given in Tables 35 to 41. As indicated earlier, one meteorological station was selected in each of the seven basins. To conduct the water budget calculations, the following assumptions had to be made:

- the temperature data measured at one station are representative of the temperature variations within the basin where the station is located,

- the precipitation data measured at one station are representative of the precipitation variations within the basin where the station is located,

- the streamflow data measured at the selected gauging stations are accurate,

- the soil moisture capacities assigned to various basins are reasonably accurate.

Given the inherent weaknesses in the above assumptions, the water budget calculations are approximate and should be treated as such. Nevertheless, these calculations are extremely useful because they identify the relative magnitudes of the various hydrologic processes and their interrelationships within the study area. It should also be emphasized that although the calculations can be improved with more and better data, there is no way to prove that they are fully correct.

8. GROUNDWATER QUALITY

8. 1 GENERAL INFORMATION

The chemical composition of groundwater is an important consideration in any hydrogeologic study. The suitability of groundwater for use by agriculture, commerce, industry, or for drinking purposes can be assessed by a study of its chemistry.

The Ontario drinking water standards and objectives were established to help with meeting the legislative requirements governing water works under the Ontario Water Resources Act and should be used with the Drinking Water Resources Regulation. These standards and objectives have been derived from the best information currently available and are continually being reviewed as new and more significant data become available.

Two types of standards have been established, Maximum Acceptable Concentration (MAC) and Interim Maximum Acceptable Concentration (IMAC). The MAC is a health-related standard. It was established for parameters that, when present above a certain concentration, have known or suspected health effects. The IMAC is also a health-related standard. It is used when the toxicological data to establish a MAC are insufficient, or when establishing a MAC at the desired level is not feasible for practical reasons.

In addition, Aesthetic Objectives (AO) and Operational Guidelines (OG) were established. Aesthetic Objectives are for parameters that may impair the taste, odour or colour of water, or may interfere with good water quality control practices. Operational Guidelines, on the other hand, are for parameters that need to be controlled to ensure efficient and effective treatment and distribution of the water.

Most of the parameters that are routinely found in natural groundwater are associated with chemical or physical objectives that are not health related. The following is a list of these parameters:

Parameter	**Objective (mg/L)**	**Aesthetic Objective or Operational Guideline**
Alkalinity (as $CaCO_3$)	30 -500	OG
Chloride	250	AO
Iron	0.3	AO
Manganese	0.05	AO
Sodium	200	AO
Sulphate	500	AO
Sulphide	0.05	AO
Total Dissolved Solids	500	AO

The Aesthetic Objective for water colour is 5 True Colour Units and the Operational Guideline for pH is 6.5 to 8.5 (no units). Further, odour and taste of the water should be inoffensive.

Arsenic and lead are found at times in natural groundwater. The IMAC for arsenic is 0.025 mg/L and the MAC for lead at the point of consumption is 0.01 mg/L. Groundwater may become contaminated by nitrate. The MAC for nitrate (as nitrogen) is 10.0 mg/L. Where nitrate and nitrite are present, the total of the two should not exceed 10.0 mg/L (as nitrogen).

Hardness is caused by dissolved calcium and magnesium, and it is expressed as the equivalent quantity of a calcium carbonate. The Operational Guideline for hardness in drinking water is set at between 80.0 and 100.0 mg/L as calcium carbonate. This range for hardness is set to provide an acceptable balance between corrosion and incrustation of pipes, and to aid in water source selection where a choice exists. Water supplies with a hardness level greater than 200.0 mg/L are considered poor but tolerable. Hardness levels more than 500.0 mg/L in drinking water are unacceptable for most domestic purposes.

Natural groundwater has often superior water quality, which makes it highly attractive as a source of drinking water supply. Unfortunately, groundwater in some aquifers does not always meet all the standards, objectives and guidelines and may contain high levels of total dissolved solids, hardness, sulphate, hydrogen sulphide, or iron. Home treatment devices are available to treat these problems.

Overall, natural groundwater has very low levels of nitrate and is free from bacteria. Therefor, the detection of high levels of nitrate or any amounts of faecal or total coliform bacteria in a sample collected from a water well shows that the well has been contaminated. Most well contamination is the result of poor location, inferior construction methods, or inadequate maintenance.

Most well records on file with the Ministry of the Environment include information related to the kinds of groundwater encountered as fresh, salty, sulphurous, or containing iron or gas. This information is submitted by the well driller as part of the well record. Usually, the driller examines visually a water sample taken from the well for clarity. The driller then smells and tastes the water and enters appropriate observations into the well record. These observations are very useful especially when the water tastes salty or smells like a rotten egg, showing the presence of sodium chloride or hydrogen sulphide. The driller’s observations, however, are subjective and inadequate for determining the suitability of groundwater for drinking purposes.

8. 2 GROUNDWATER QUALITY IN THE BEDROCK

Overall water obtained from bedrock wells within the study area show high levels of hardness, with values frequently exceeding 250.0 mg/L. In addition, problems with iron and manganese are widespread and the use of water treatment devices is common. Further, in isolated areas, metals such as arsenic, cadmium, nickle, lead, copper, and zinc can present problems.

General information related to the quality of water encountered in Precambrian rocks is available for 8,560 wells. The records show that 8,463 wells yield fresh water, 60 wells yield salty water, 20 wells yield sulfurous water, 16 wells yield mineral water, and one well contains gas. In addition, information related to the quality of water encountered in Paleozoic rocks is available for 1,791 wells. The records show that 1,762 wells yield fresh water, 17 wells yield sulphurous water, and six wells yield salty water.

Wang and Chin (1978) described the results of 53 chemical analyses for water samples collected from wells in Precambrian rocks within the area draining into the Hudson Bay and James Bay. The results showed that the water in these rocks is of a calcium-bicarbonate type, and it is generally hard and contains high levels of iron. Median concentrations of total dissolved solids and sulphate for the samples were 400.0 mg/L and 10.0 mg/L, respectively.

Singer et al. (1997) described the results of eight chemical analyses for water samples taken from wells in Precambrian rocks within southern Ontario. The results were as follows:

Parameter	**Minimum** (mg/L)	**Mean** (mg/L)	**Maximum** (mg/L)
Sodium	16.0	40.5	123.0
Iron	0.1	7.3	57.0
Chloride	5.8	53.8	149.0
Sulphate	9.7	16.5	635.0
Hardness	112.0	250.0	550.0
Total Dissolved Solids	261.0	412.3	514.0

Two of the eight samples were of a calcium-bicarbonate type and one was of a bicarbonate type.

The results of 177 chemical analyses for samples of known geographic coordinates are available for wells completed in Precambrian rocks in northern Ontario. Most of these wells, however, are outside the study area. The following list gives a summary of the results:

Parameter	Minimum (mg/L)	Mean (mg/L)	Maximum (mg/L)
Calcium	1.0	74.4	630.0
Magnesium	0.1	19.9	110.0
Sodium and Potassium	2.2	55.9	503.3
Iron	0.0	1.3	60.0
Manganese	0.0	0.7	67.0
Chloride	0.4	136.1	1,990.0
Carbonate	9.3	84.0	252.2
Sulphate	0.1	16.5	67.0

The hardness concentrations are available for 133 analyses and they range from 17.0 to 3,333.0 mg/L with a mean of 394.0 mg/L. In addition, eighty-two analyses showed the presence of nitrate in the water samples. All the reported nitrate concentrations are less than 6.2 mg/L, and 50% of all the values is less than 0.7 mg/L. One value, however, is 11.2 mg/L. The nitrate results showed that some contamination is taking place because of human activities (Figure 30).

Wang and Chin (1978) described the results of 20 chemical analyses for water samples obtained from Paleozoic rocks. Five samples were obtained from the Moose River basin and 15 samples were obtained from the Albany River basin. The samples obtained from the Moose River basin were of a sodium-chloride type. They had a mean concentration of total dissolved solids of more than 4000.0 mg/L. Five samples obtained from the Albany River basin were of a calcium-bicarbonate type and two samples were of a sodium-chloride type.
The samples showed high levels of iron, hardness, and total dissolved solids.

According to Wang and Chin (1978), groundwater in the Paleozoic rocks within the area draining into the Hudson Bay and James Bay contains higher levels of dissolved solids than the groundwater found in the overburden or Precambrian rocks. Further, a general increase in the concentration of total dissolved solids is observed in the Paleozoic rocks as one moves from the inland areas toward the coast.

The results of 33 chemical analyses for samples obtained in eastern Ontario from wells in the Nepean-March-Oxford hydrologic unit were reported by Singer et al. (1997). The results were as follows:

Parameter	Minimum (mg/L)	Mean (mg/L)	Maximum (mg/L)
Sodium	1.0	21.9	138.0

Iron	0.1	1.3	15.0
Sulphate	15.0	55.7	180.0
Hardness	92.0	320.8	870.0
Total Dissolved Solids	268.0	468.3	1380.0

Results of the above analysis showed that most of the samples were of a bicarbonate type, or a calcium-bicarbonate type.

According to Singer et al. (1997), the results of 39 chemical analyses are available for samples obtained from wells completed in the Ottawa Group in eastern Ontario. The results of these analyses were as follows:

Parameter	**Minimum** (mg/L)	**Mean** (mg/L)	**Maximum** (mg/L)
Sodium	3.6	166.5	1310.0
Iron	0.1	0.6	7.5
Sulphate	3.0	57.0	435.0
Hardness	30.0	277.9	530.0
Total Dissolved Solids	276.0	732.9	2874.0

Water type analyses were conducted on 32 samples (Durov 1948). The analyses showed that 82% of the samples had water of a calcium-bicarbonate type or a bicarbonate type. The remaining samples had water of a sodium-potassium-bicarbonate type. It is believed that the above results are valid for groundwater quality in the Ottawa Group within the Upper Ottawa River basin.

8. 3 GROUNDWATER QUALITY IN THE OVERBURDEN

General information related to the quality of groundwater in the overburden is available for 2,259 wells. The records show that 2,218 wells yield fresh water, 25 wells yield salty water, 12 wells yield mineral water, and four wells yield sulphurous water.

Wang and Chin (1978) described the results of chemical analyses for 77 samples collected from the Moose River basin, 43 samples collected from the Albany River basin, and 16 samples collected from the Attawapiskat, Winisk and Severn River basins. The samples collected from the Moose River basin showed a calcium-bicarbonate type water with high magnesium, sodium, and iron levels. The hardness was generally high and the concentrations of the total dissolved solids were less than 700.0 mg/L with a median of 400.0 mg/L.

According to Wang and Chin (1978), the water samples collected from the Albany River basin were also of a calcium-bicarbonate type with high levels of hardness, magnesium, and iron. The concentrations of total dissolved solids ranged from 414.0 to 790.0 mg/L with a median of 240.0 mg/L. The water samples collected from the Attawapiskat, Winisk and Severn River basins were of a calcium-bicarbonate type with high levels of hardness and iron. The concentrations of total dissolved solids in these samples ranged from 40.0 to 835.0 mg/L with a median of 1,145.0 mg/L.

The results of 60 chemical analyses are available for samples collected from wells completed in the overburden in northern Ontario. Most of the sampled wells, however, are outside the study area. The following list gives a summary of the results:

Parameter	**Minimum** mg/L	**Mean** mg/L	**Maximum** mg/L
Calcium	15.0	69.5	220.0
Magnesium	5.0	24.3	85.0
Sodium and Potassium	1.7	33.4	227.2
Iron	0.0	0.9	15.9
Manganese	0.0	0.1	0.7
Chloride	0.5	64.3	710.0
Carbonate	10.8	114.3	254.2
Sulphate	0.4	41.8	376.0

The reported hardness for 40 analyses ranged from 30.0 to 898.0 mg/L with a mean of 290.9 mg/L. In addition, twenty-five analyses showed the presence of nitrate in the water samples, which is likely due to contamination related to human activity. All the reported nitrate concentrations, however, were less than 2.1 mg/L (Figure 31).

8.4 SUSCEPTIBILITY OF GROUNDWATER TO CONTAMINATION

Groundwater susceptibility to contamination is a major factor that has to be considered in the implementation of a provincial groundwater monitoring network. Groundwater is susceptible to contamination from many types of pollutants that can travel rapidly downward from the surface to the water table. These pollutants originate either from point or non-point sources.

Potential point sources of pollution include municipal sanitary landfill sites, industrial waste storage and disposal sites, municipal and industrial liquid waste impoundments, major spills, underground gasoline storage tanks, mine tailings, radioactive wastes, coal tar sites, coal and coal ash from thermal power plants, PCB storage areas, deep well injection from industrial waste, and brine disposal lagoons.

Non-point sources that can impact the groundwater quality include industrial and municipal operations (pipelines, minor spills, and road deicing salts), agricultural activities (fertilizer and pesticide use, spreading of animal manure, and irrigation), urban drainage, septic systems, unprotected domestic and abandoned wells, and acid rain and atmospheric fallout.

It is important to keep the relative impacts of various potential contaminant sources in perspective. For example, municipal and industrial landfill and disposal sites have a very high public profile, their approval is subject to lengthy public hearing, their potential impact on the quality of groundwater is extensively evaluated, and their operations are controlled by certificates of approval. Non-point sources of contamination, on the other hand, are more difficult to assess and control.

A number of hydrogeologic factors commonly control the movement of contaminants into the ground, including:

- the permeability of the near surface materials,
- the direction of groundwater movement,
- the presence of major, shallow aquifers, and
- groundwater use.

Based on the above factors, six areas with specific hydrogeologic environments have been identified within the study area. Groundwater in each of these areas has its own level of susceptibility to contamination.

8.4.1 Area 1 - Canadian Shield

The rocks of the Canadian Shield are exposed over large portions of the study area, or they are covered with a thin veneer of overburden deposits. Therefore, groundwater within the Shield has generally a high susceptibility to contamination. Further, contaminated water may spread over large areas.

8.4.2 Area 2 - Deposits of Sand and Gravel of Glaciofluvial, Glaciolacustrine and Glaciomarine Origin

Sands and gravels of glaciofluvial, glaciolacustrine, or glaciomarine origins are also present at or close to the surface over large portions of the study area. Often there is little protection for them by the overlying fine-textured deposits. As a result, groundwater in these deposits is highly susceptible to contamination. Where the sands and gravels are flat lying, however, contaminants that reach groundwater are likely to remain at shallow depths.

8.4.3 Area 3 - Sand to Silty Sand Till Deposits

The sand to silty sand till deposits of Map Unit 18 have been mapped in many locations within the Upper Ottawa River basin and within the headwaters of the Severn, Winisk, Attawapiskat, Albany, and Moose River basins. Drumlin fields and areas of De Geer moraines are associated with this till. The drumlins are composed of a till or stratified sediments. The De Geer moraines, on the other hand, consist of a series of regularly spaced, small ridges, which consist of till and stratified sediments.

Due to the heterogeneity of deposits, the susceptibility of groundwater to contamination in this area is variable. Further, because the relief within in the area is irregular, the movement of contaminants with groundwater is also variable.

8.4.4 Area 4 - Silty Clay Till Deposits

The silty clay till deposits of Map Unit 21 have been mapped over large areas in the Moose River basin, and it has been mapped within parts of the headwaters of the Severn, Winisk, Attawapiskat, and Albany River basins. Because the till consists mainly of clay and silt, groundwater has generally a low susceptibility to contamination in this area.

8.4.5 Area 5 - Clay Deposits of Glaciolacustrine and Glaciomarine Origin

Large plains of glaciolacustrine deposits consisting of silt and clay with minor sand occur in the headwaters of the Severn, Winisk, Albany, Moose, and Upper Ottawa River basins. In addition, glaciomarine deposits of silty clays and clays have been deposited in the Tyrrell Sea within the Hudson Bay Lowlands. These deposits are characterized by very low susceptibility to groundwater contamination.

8.4.6 Area 6 - Paleozoic Rocks

The Paleozoic rocks of the Hudson Bay Lowlands are protected from contamination by the clay and silt deposits left by the Tyrrell Sea and by the veneer of recent deposits of peat, muck, and marl. Groundwater susceptibility to contamination in these rocks, therefore, is low. The Paleozoic rocks of the Upper Ottawa River basin, however, are exposed at the surface and have generally a high susceptibility to contamination.

8.5 POTENTIAL CONTAMINATION THREATS

Based on the above, it is possible to conclude that most groundwater supplies within the study area are quite susceptible to contamination. Because of the climate of the study area and its land use, it is expected that the main sources of groundwater contamination would be salt drainage associated with highway deicing operations, septic systems, and fuel leaks from underground storage tanks.

Large quantities of salt, perhaps between 10.0 and 60.0 tonnes/year, are being applied to every kilometre of Provincial highways in northern Ontario. In addition, salt loadings to the environment from Patrol yards can be substantial. These loadings originate from the waste water used to wash equipment and from yard runoff which picks-up spilled salt. The net result is a strong potential for groundwater contamination by salt-enriched runoff mainly along transportation corridors.

Properly designed, operated and maintained septic tanks and leaching bed systems have a proven record of providing an economical and environmentally acceptable method of treating and disposing of domestic sewage. In area where the soil is shallow, however, such systems could have negative impact upon groundwater quality.

Contamination by leaking underground storage tanks could also pose a potential problem. Under certain circumstances, such contamination could spread over a large area, which makes clean up very difficult and costly. In the past most leaks in Ontario were associated with corrosion of steel tanks and pipes. Following the recent legislation that requires the replacement of all unprotected tanks, however, most leaks today are due to failures at joints in distribution piping.

Many resource-based industries, including pulp and paper operations and metal wining activities, are found within the study area. Effluent from the waste treatment and coal and ash storage facilities associated with these industries may pose threats to groundwater. It is expected, however, that the threat will be localized in small areas. In addition, many small waste disposal sites are found within the study area. The environmental effects of these sites, however, should be localized.

Agricultural activities within the study area are small. Therefore, it is expected that pesticide related problems would be small. For the same reason, the contribution of agricultural activities to nitrate contamination of groundwater is also expected to be very limited.

9. 0 SUMMARY AND OBSERVATIONS

A hydrogeologic study was undertaken to evaluate the groundwater distribution, quantity and quality in areas draining into the Hudson Bay, James Bay, and the Upper Ottawa River. In addition, the study used a mass balance approach to calculate the monthly, annual, and long-term components of the water budgets for seven major basins within the study area. A summary of the results and some specific observations regarding the availability of data and information are given below.

9.1 SUMMARY OF RESULTS

1. Groundwater in the study area is a major source of water supply for domestic and municipal purposes, livestock watering, and commercial and industrial operations. It is also critical for the survival of fish and aquatic life in the area's watercourses. A total of 14,705 records for wells constructed after 1945 is on file with the MOE. No information is available for wells constructed before 1945.

2. The Precambrian rocks of the Canadian Shield and the Paleozoic rocks within the Upper Ottawa River basin are the most important bedrock hydrogeologic units in the study area.

3. Two groundwater systems have been identified within the Precambrian rocks. A shallow system of fresh water that has been explored to a depth of about 150 m, and a deep system of brine water that extends hundreds of meters in depth. The shallow groundwater system is significant as a source of groundwater supply, and it is characterized by many small, localized aquifers.

4. In some parts of the study area, the groundwater flow systems in the overburden and the bedrock may be hydraulically connected.

5. Significant movement of groundwater in the shallow bedrock is entirely dependent on secondary permeability created by fractures. The intensity and distribution of the fracture system play a major role in determining the total porosity of the rocks of the Canadian Shield, and their hydraulic conductivity, water yield, and infiltration rate.

6. More than 10,000 records for wells in the Canadian Shield were examined. A total of 717 wells has been reported as dry. In all the productive wells, water was found at depths of 280.4 m or less. Approximately 90% of the wells obtain water at depths of 67.1 m or less. The geometric mean for the specific capacity distribution for these wells is 1.9 L/min/m.

7. Most of the wells that obtain water from the Paleozoic rocks are within the Upper Ottawa River basin. About 50 wells obtain water from Paleozoic and Mesozoic rocks in the remaining parts of the study area, and most of these wells are for test holes drilled by the MOE and the Canada Department of the Environment.

8. Limestones, dolostones, and sandstones that are at or close to the surface within the Hudson Bay Lowlands can be regarded as potential aquifers. Poor water quality in these deposits, however, could be a major impediment.

9. A total of 1,944 wells has been identified within the Paleozoic rocks in the Upper Ottawa River basin. Of these wells, 68 have been reported to be dry. Water was found in 90% of the wells at depths of 65.5 m or less. The geometric mean of the specific capacity distribution for these wells is 3.5 L/min/m.

10. Bedrock wells in the Upper Ottawa River basin are found within the Beekmantown Group (Lower Ordovician), Ottawa Group (Middle and Upper Ordovician), Liskeard Group (Middle and Upper Ordovician), Wabi Group (Lower and Middle Silurian), and the Earlton and Thornloe Formations (Middle Silurian).

11. Deposits of sands and gravels of glaciofluvial, glaciolacustrine, glaciomarine, and recent origins are widespread within the overburden covering an area of about 51,300 km^2. This is about half the size of southern Ontario. These deposits, especially when they are large in areal extent and thickness, could act as important aquifers.

12. The total number of overburden wells within the study area is 2,737 and most of them are within the Upper Ottawa and the Moose River basins. A total of 309 wells has been reported as dry. Approximately 90% of the productive wells obtain water at depths of 50.3 m or less. The geometric mean of the specific capacity distribution for these wells is 5.1 L/min/m.

13. As part of this study, the water budgets for the Severn, Winisk, Attawapiskat, Albany, Moose, Montreal, and Petawawa River basins were calculated.

14. The minimum monthly temperatures occur mainly during the period November to April, and the maximum monthly temperatures occur mainly during the period May to August.

15. Most precipitation falls as showers and thunderstorms during June to September, and as snow during October to May. The annual precipitation amounts increase from northwest to southeast - a reflection of the increasing influence of moisture transported from the Great Lakes and the Gulf of Mexico.

16. During the fall and winter seasons a considerable part of precipitation falls as snow. Therefore, precipitation during almost half the year is locked in a snowpack. As a result, the amount of available liquid water in the study area on an annual basis could in some years be less than the precipitation and in others more. Further, liquid water during almost half the year is not available to recharge groundwater or as a surface runoff. During this period, the streamflow is sustained by surface storage in various lakes and by groundwater discharge as baseflow.

17. The combined amount of rainfall and snowmelt within the study area in November, December, January, February, and March is almost nil, and it is far less than the precipitation. On the other hand, in March, April and frequently May rainfall and snowmelt are much larger than precipitation. The large volume of water released during March, April, and May generates high flows and sometimes floods and it contributes substantially to the groundwater storage through the infiltration process.

18. When the supply of water is not limiting, evapotranspiration occurs at the potential rate. If the water supply is insufficient, on the other hand, actual evapotranspiration will fall short of potential evapotranspiration. From November to May, the actual evapotranspiration is almost nil. However, it becomes substantial during the period June to October. Highest monthly values occur during the months of June, July, and August.

19. Highest river flows occur during the spring melting season between May and June and sometimes April. Lowest flows within the Severn, Winisk, Attawapiskat, Albany, and Moose River basins occur mainly in January, February, March, and April. This is because extremely low temperatures in the winter cause precipitation to be stored as snow, which inhibits surface runoff. Flow in these basins during the winter is mainly from water stored in lakes and from groundwater discharge.

20. Highest flows in the Montreal and Petawawa Rivers, which are part of the Upper Ottawa River system, occur mainly during April and May, but the lowest flows occur during the summer and fall.

21. Separation of flow for eleven small watersheds within the study area shows that the groundwater contributions to the flow vary from one watershed to another on a daily, monthly, annual, and long-term basis. This reflects variations in geologic and climatic conditions. The smallest groundwater contributions occur in November to March and the largest contributions occur mostly in May to July.

22. Groundwater is a resource that is being renewed annually through the process of recharge. Most of the recharge occurs where sands and gravels of glaciofluvial, glaciolacustrine and glaciomarine origin outcrop at the surface. It occurs at a maximum rate when the soil is in a state of complete saturation, and it diminishes

when the soil is at the dry limit. This condition is met mainly during the snowmelt and spring rainfall events that usually extends from May through June and early July. During the summer and early fall, the soil moisture is used mainly by plants through evapotranspiration and a state of soil moisture deficiency usually prevails. Therefore, most of the infiltrated water from the rain, during this period, is used to satisfy this deficiency with no water left to recharge the groundwater. Precipitation from November to April is mainly as snow, and it is not available for groundwater recharge.

23. The long-term mean annual groundwater recharge for the study area was estimated to ranges from 33.6 - 44.0 mm, which is approximately equivalent to a range of 57.0 to 75.0 million cubic meters per day. This range represents also the long-term mean annual groundwater discharge within the study area.

24. Chemical analyses for 237 water samples, collected from wells completed in various bedrock and overburden units, were used to evaluate the natural groundwater quality. Overall water obtained from many bedrock wells within the study area show high levels of hardness with values frequently exceeding 250.0 mg/L. In addition, problems with iron and manganese in wells are widespread and the use of water treatment devices is common. Further, in isolated areas, metals such as arsenic, cadmium, nickle, lead, copper, and zinc can present problems. Some water samples collected from wells completed in the overburden also show high levels of hardness, chloride, sulphate, and iron.

25. To characterize the susceptibility of groundwater to contamination, six hydrogeologic environments were identified within the study area.

26. The Canadian Shield and areas where sand and gravel deposits occur at the surface are two environments that are highly susceptible to contamination.

27. In areas where sand to silty sand till deposits occur at the surface, groundwater susceptibility to contamination is variable.

28. Groundwater in areas where silty clay till deposits or clay deposits occur at the surface has low susceptibility to contamination.

29. Paleozoic rocks within the Hudson Bay Lowlands are protected from contamination by the clay and silt deposits left by the Tyrrell Sea, and by the veneer of recent deposits of peat, muck, and marl. Therefore, groundwater in these rocks has low susceptibility to contamination. The Paleozoic rocks within the Upper Ottawa River basin, however, are not protected and groundwater in them has generally a high susceptibility to contamination.

30. The three potential sources of groundwater contamination in the study area are salt drainage associated with highway deicing operations, faulty septic systems, and fuel leaks from underground storage tanks.

31. Many resource-based industries are found within the study area. Effluent from the waste treatment and coal and ash storage facilities associated with these industries may pose threats to groundwater.

32. Agricultural activities within the study area are small. Therefore, it is expected that pesticide and nitrate related problems would be small.

9. 2 GENERAL OBSERVATIONS

Much information related to the water resources of the study area has been found during the preparation of this report. Nevertheless, some important environmental data either are clearly unavailable, inaccessible, incomplete, or have been lost. A comprehensive database that is being regularly maintained and allows for the easy retrieval of information, is an essential tool for the appropriate management of the water resources of the study area. Such a database should contain current information related to climate, streamflow, land use, water use (Permits to Take Water and municipal withdrawals), environmentally significant areas, water wells, geologic and technical test drilling, groundwater monitoring, and stream water quality. The following observations and actions are being proposed for consideration.

9.2.1 Climatic Data

A few meteorological stations are still in operation within the study area. Further, the type and continuity of the climatic records at the various stations are highly variable which make it extremely difficult to compare the basic climatic factors of temperature and precipitation over concurrent periods throughout the study area. The continued operation of stations that are strategically distributed throughout the study area is very important for the management of the area's water resources.

9.2.2 Streamflow Data

Streamflows data are essential for water budget analysis and the evaluation of groundwater discharge and recharge. When such data are available at points strategically distributed within a basin, the variations of groundwater discharge can be investigated and areas of recharge can be mapped. Long-term streamflow data are available at many stations within the study area. The records at most of the stations, however, are not

concurrent. Further in the mid-nineties many gauging stations were closed most likely because of budgetary constraints.

9.2.3 Groundwater Quality Data

Available data related to groundwater quality within the study area is very limited. Further, most of the available data is for water wells with no geographic coordinates, which makes the interpretation and extrapolation of the data very difficult. It is highly recommended that Geographic Positioning System equipment be used whenever a sample is collected from a well for chemical or bacteriological analyses. Over time, a large database would become available to characterize the groundwater quality in the study area.

9.2.4 Water Use

To enhance the management of water in the study area, it is extremely important to identify the large water users by location, sources of water, types of water use, and amounts of water takings. Further, in cooperation with local municipalities, a special effort should be made to obtain up-to-date information regarding the amounts of water withdrawals from various wells, the pumping levels in the wells, and the water levels the in the municipal observation wells.

9.2.5 Groundwater Monitoring Network

In cooperation with local conservation authorities and municipalities, a groundwater monitoring network should be established. The objective of such a network should be to collect long-term quantity and quality information regarding the ambient local groundwater conditions. The following areas are suggested for monitoring:

- Precambrian Rocks,
- Paleozoic rocks within the Upper Ottawa River basin,
- Sands and gravels within the overburden.

Areas where the overburden is thick within the Upper Ottawa and Moose River basins (Figure 14) are good candidates for monitoring purposes.

9.2.6 Technical and Geologic Drilling

Every year, many technical test holes are being drilled in northern Ontario as part of mineral explorations or mining operations. The geologic logs of thousands of such test

holes have been compiled by the Ministry of Mines and Northern Affairs. The geologic logs, however, do not describe the overburden deposits nor provide any details regarding groundwater. It would extremely useful to identify in these test holes the types of overburden deposits encountered, the depths at which groundwater was found, and the final static levels.

9.2.7 Municipal Water Supplies

In cooperation with local municipalities, an effort should be made to collect information on test drilling for municipal water supplies. Drillers should be encouraged to provide the best possible descriptions of the geologic logs for these test wells. Such data is very useful for understanding the hydrogeology of local areas. Further, in cooperation with municipalities, a comprehensive bibliography of consultant reports and technical bulletins should be established and maintained.

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TABLES

Table 1. Climatological statistics recorded at various meteorological stations in the study area.

(Temperature values are in degrees Celsius, all others are in mm)

Station Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Big Trout Lake													
Minimum Temperature	-47.8	-46.7	-42.2	-32.8	-20.6	-7.2	-1.1	-1.1	-7.8	-19.3	-36.0	-44.4	-47.8
Maximum Temperature	1.9	7.7	12.2	24.4	32.4	31.7	35.6	32.9	30.6	24.4	12.2	4.7	35.6
Precipitation	24.2	19.3	25.3	30.6	42.1	68.6	89.0	82.8	77.4	54.0	45.6	28.0	586.8
Snow	24.2	19.3	24.4	21.0	8.5	0.4	0.0	0.0	1.5	21.6	42.8	27.6	191.4
Potential Evapotranspiration	0.0	0.0	0.0	1.3	45.0	98.0	125.5	105.1	56.1	13.9	0.0	0.0	445.0
Actual Evapotranspiration	0.0	0.0	0.0	1.3	45.0	95.5	107.0	83.0	52.2	13.8	0.0	0.0	397.7
Winisk													
Minimum Temperature	-44.4	-47.2	-41.7	-36.7	-20.6	-6.1	-3.3	-1.7	-5.0	-17.8	-32.2	-46.1	-47.2
Maximum Temperature	10.0	0.6	7.2	14.4	26.7	29.4	35.6	30.6	26.7	17.2	10.6	1.1	35.6
Precipitation	12.7	4.6	4.6	29.2	36.0	98.1	55.7	84.4	56.8	48.5	22.9	17.9	471.4
Snow	12.7	4.6	4.6	29.2	21.6	8.6	0.0	0.0	0.0	0.0	19.1	17.9	118.3
Potential Evapotranspiration	0.0	0.0	0.0	0.0	0.0	73.3	117.1	100.7	60.2	33.2	0.0	0.0	384.5
Actual Evapotranspiration	0	0	0	0	0	73.26	117.1	87.62	57.46	33.16	0	0	368.62
Lansdowne House													
Minimum Temperature	-47.8	-45.6	-42.8	-32.8	-17.2	-4.4	0.6	1.1	-7.2	-15.6	-33.4	-43.3	-47.8
Maximum Temperature	3.3	9.9	15.6	25.6	32.8	35.0	36.7	35.0	29.4	24.4	17.2	7.2	36.7
Precipitation	29.5	23.8	28.6	41.8	53.3	81.4	95.9	88.7	80.8	60.4	48.7	33.3	666.2
Snow	29.5	23.5	26.6	28.5	6.5	0.0	0.0	0.0	0.3	18.2	40.7	33.1	206.9
Potential Evapotranspiration	0.0	0.0	0.0	2.3	51.1	103.5	128.1	107.3	58.9	18.8	0.0	0.0	470.1
Actual Evapotranspiration	0.0	0.0	0.0	2.3	51.1	102.8	112.2	87.9	55.6	18.2	0.0	0.0	430.1
Fort Albany													
Minimum Temperature	-47.2	-44.5	-40.5	-31.7	-17.8	-16.7	-11.1	-7.8	-8.0	-16.0	-33.0	-46.0	-47.2
Maximum Temperature	4.0	8.0	39.0	38.0	38.9	39.5	35.6	35.6	31.1	24.0	18.5	11.0	39.5
Precipitation	14.7	15.4	12.9	12.1	40.2	82.3	104.3	89.4	75.2	42.6	23.4	26.7	539.2
Snow	14.7	15.4	12.3	6.1	9.8	4.0	2.6	0.0	2.4	11.1	14.8	25.3	118.5
Potential Evapotranspiration	0.0	0.0	0.0	0.0	66.9	84.4	119.1	99.2	65.5	11.9	0.0	0.0	447.1
Actual Evapotranspiration	0.0	0.0	0.0	0.0	66.9	78.3	67.9	63.5	65.2	11.9	0.0	0.0	353.7

Moosonee

Minimum Temperature	-46.7	-46.1	-41.7	-31.7	-17.2	-7.0	-2.2	-3.1	-6.1	-16.7	-34.4	-44.4	-46.7
Maximum Temperature	7.2	14.3	19.4	26.7	34.0	34.4	37.8	35.0	32.2	26.7	18.9	13.2	37.8
Precipitation	40.6	34.2	38.6	42.4	62.2	81.5	96.1	81.8	86.5	72.2	66.9	43.1	746.3
Snow	40.0	33.9	34.4	21.9	7.4	1.0	0.0	0.0	1.0	8.3	45.7	41.2	234.7
Potential Evapotranspiration	0.0	0.0	0.0	2.6	57.1	95.1	117.9	102.8	63.0	22.6	0.0	0.0	461.1
Actual Evapotranspiration	0.0	0.0	0.0	2.6	57.1	90.5	106.9	88.5	63.0	22.6	0.0	0.0	431.1

Lake Traverse

Minimum Temperature	-42.0	-40.5	-35.5	-18.3	-10.6	-3.9	-0.6	-2.0	-6.0	-12.2	-26.1	-39.4	-42.0
Maximum Temperature	11.1	12.0	23.3	30.0	33.9	33.9	37.2	36.7	32.2	28.3	20.6	17.0	37.2
Precipitation	51.7	45.3	50.4	57.6	68.4	82.2	79.5	76.9	82.9	66.6	68.5	66.5	796.6
Snow	49.3	40.3	32.9	9.7	0.0	0.0	0.0	0.6	0.0	3.7	29.8	60.5	226.7
Potential Evapotranspiration	0.0	0	0.2	22.5	72.4	106.7	126.7	108.6	68.5	32.5	1.6	0.0	539.7
Actual Evapotranspiration	0.0	0.0	0.2	22.5	72.4	95.3	86.9	78.1	65.0	31.9	1.6	0.0	453.9

New Liskeard

Minimum Temperature	-48.0	-46.7	-42.8	-28.9	-12.8	-3.9	0.0	-2.8	-7.8	-12.8	-33.3	44.4	-48.0
Maximum Temperature	9.4	12.0	24.4	30.0	35.0	36.1	37.8	36.7	34.4	28.3	20.6	16.0	37.8
Precipitation	43.9	23.9	38.2	42.4	58.3	93.6	79.8	68.6	70.8	72.9	49.5	34.6	676.5
Snow	43.5	23.8	33.1	12.9	8.8	3.4	8.1	5.3	5.5	10.8	25.5	32.1	212.8
Potential Evapotranspiration	0.0	0.0	0.0	10.7	69.6	101.7	127.2	105.0	65.8	33.1	0.1	0.0	513.2
Actual Evapotranspiration	0.0	0.0	0.0	10.7	67.1	92.3	89.8	64.6	59.8	32.9	0.1	0.0	417.4

Table 2. Mean monthly temperatures recorded at various meteorological stations in the study area.

(All values in degrees Celsius)

Basin: Severn River
Station: Big Trout Lake

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1954	-29.10	-15.67	-15.48	-7.23	1.95	13.02	17.29	14.47	8.14	2.95	-6.96	-15.71
1955	-23.57	-21.79	-18.55	1.57	6.81	15.56	17.43	16.89	8.09	2.96	-7.89	-21.11
1956	-20.45	-20.25	-16.97	-5.60	-0.34	12.97	15.16	14.42	5.42	3.03	-9.28	-23.42
1957	-27.41	-19.62	-11.91	-4.27	3.31	10.32	17.43	14.15	9.61	3.94	-10.60	-19.10
1958	-18.75	-23.44	-9.90	-3.59	1.66	8.67	15.11	12.35	9.10	2.48	-7.76	-22.81
1959	-26.40	-21.99	-13.36	-7.49	3.00	10.82	16.63	14.43	9.41	-1.65	-14.21	-16.03
1960	-21.60	-20.50	-16.97	-5.60	6.24	13.10	15.45	15.56	9.11	1.37	-10.33	-21.07
1961	-24.15	-18.62	-12.76	-4.11	4.18	11.87	17.85	15.15	8.04	1.29	-7.12	-19.91
1962	-27.31	-26.45	-11.25	-6.63	3.94	14.28	15.42	14.07	8.80	3.76	-7.35	-21.27
1963	-27.38	-24.13	-17.07	-3.34	2.22	12.46	17.91	14.47	7.66	7.94	-7.36	-20.49
1964	-20.67	-19.07	-20.57	-4.24	6.07	11.00	16.85	12.12	7.81	1.48	-9.13	-23.04
1965	-24.63	-25.11	-17.67	-3.09	4.75	12.02	12.88	12.37	6.40	1.99	-11.17	-16.10
1966	-26.14	-19.73	-12.68	-3.93	3.19	12.20	16.74	14.00	10.09	-0.06	-14.84	-21.35
1967	-24.46	-26.60	-15.99	-9.11	0.60	12.11	15.32	14.59	12.25	1.08	-9.21	-16.88
1968	-24.33	-22.51	-10.69	-1.80	6.51	11.57	13.34	11.91	12.73	2.52	-8.36	-18.05
1969	-21.95	-16.91	-16.68	-1.67	2.87	7.87	16.58	16.65	5.69	-0.75	-7.14	-15.07
1970	-24.01	-25.00	-14.34	-5.30	1.95	13.34	17.43	15.63	8.80	3.48	-7.96	-23.44
1971	-25.00	-17.58	-13.67	-3.24	4.78	13.35	13.85	14.25	9.72	3.57	-8.92	-19.11
1972	-29.01	-25.92	-15.28	-3.59	6.51	13.42	14.26	14.81	5.91	-1.68	-11.77	-25.86
1973	-20.51	-22.41	-8.36	-6.05	4.62	11.25	15.80	18.14	8.43	3.85	-8.77	-23.16
1974	-28.54	-22.86	-19.05	-4.82	2.40	10.77	17.33	13.49	4.37	-1.47	-6.02	-14.64
1975	-24.43	-19.60	-15.01	-3.98	6.53	14.28	16.55	14.31	7.58	2.55	-5.86	-21.14
1976	-24.89	-19.87	-16.74	-1.12	5.26	13.56	16.39	15.14	9.06	0.58	-9.85	-26.95
1977	-23.72	-18.72	-10.28	-0.58	10.16	12.63	15.51	12.07	8.84	4.89	-6.74	-20.52
1978	-23.88	-19.36	-17.01	-4.67	6.95	9.31	15.15	12.25	7.06	0.93	-11.15	-21.90
1979	-24.84	-26.19	-14.02	-3.29	4.08	12.20	17.21	12.75	6.54	-0.35	-10.07	-14.32
1980	-23.39	-21.21	-13.93	-1.41	8.12	10.40	16.16	15.21	5.86	-1.41	-9.87	-21.92
1981	-18.85	-15.76	-8.63	-5.28	4.69	11.37	18.06	16.40	8.06	1.45	-3.26	-16.80
1982	-28.38	-21.11	-14.31	-7.53	8.08	9.01	16.06	12.94	9.06	2.61	-9.89	-18.44
1983	-20.82	-19.73	-13.53	-4.27	0.99	12.63	18.33	17.83	10.00	3.26	-4.45	-24.69
1984	-26.54	-15.06	-16.13	2.43	4.90	12.83	16.62	17.55	6.41	3.23	-8.70	-22.31
1985	-22.58	-23.06	-11.16	-3.82	5.49	10.64	14.71	13.86	8.46	2.18	-12.69	-20.66
1986	-22.37	-20.77	-12.98	-1.18	8.11	10.79	15.31	13.91	6.34	0.92	-15.92	-14.56
1987	-17.20	-16.72	-8.35	1.21	7.43	14.07	16.07	13.59	10.75	0.20	-6.73	-12.96
1988	-25.41	-23.58	-12.98	-1.16	6.49	14.19	17.57	16.34	9.33	-0.08	-6.54	-20.41
1989	-23.30	-21.34	-18.05	-4.67	6.55	11.72	18.62	14.59	9.00	2.42	-15.05	-25.04
1990	-21.62	-20.85	-9.66	-5.56	5.09	11.76	16.97	16.16	7.27	0.31	-6.70	-22.82
1991	-26.92	-17.51	-11.96	0.19	7.67	15.41	17.10	16.85	7.88	-1.05	-12.08	-18.31

Basin: Winisk River
Station: Winisk

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1970	-25.46	-27.82	-15.54	-9.45	-2.95	7.06	13.53	12.45	7.60	4.01	-7.55	-23.87

Basin: Attawapiskat River
Station: Lansdowne House

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1947	-22.07	-19.49	-11.70	-7.30	1.31	12.89	18.54	17.45	9.42	8.44	-6.67	-18.11
1948	-22.15	-21.01	-12.81	-2.29	5.83	13.60	17.65	16.97	14.27	5.94	-3.46	-14.11
1949	-20.79	-23.14	-14.83	-1.25	5.75	15.06	16.27	15.20	7.46	2.32	-8.56	-18.03
1950	-28.26	-21.29	-16.09	-7.80	4.52	10.13	15.78	13.53	9.93	2.58	-7.33	-19.28
1951	-23.20	-17.69	-11.76	-2.05	8.79	14.10	16.05	14.73	8.52	1.15	-10.46	-19.27
1952	-22.47	-18.66	-12.42	1.45	8.03	13.20	16.90	15.97	9.53	-0.04	-5.65	-10.35
1953	-20.74	-17.86	-9.06	-1.43	4.59	12.95	16.69	17.86	8.31	5.31	-3.37	-17.03
1954	-26.31	-12.65	-13.76	-5.06	2.57	14.50	17.49	15.36	8.83	3.53	-5.69	-14.14
1955	-21.52	-19.68	-16.58	1.97	8.06	17.67	18.96	17.60	8.42	3.74	-6.85	-19.22
1956	-19.28	-18.72	-15.66	-5.06	0.75	14.29	15.67	14.57	6.39	4.88	-6.73	-21.84
1957	-26.08	-17.68	-11.07	-2.75	5.43	12.14	18.22	14.72	10.32	4.71	-8.94	-16.65
1958	-17.96	-21.78	-8.77	-1.19	3.39	10.75	16.23	13.40	9.69	3.21	-5.79	-21.24
1959	-24.65	-20.43	-11.16	-4.15	4.60	13.06	17.96	15.56	10.88	-0.45	-12.60	-14.73
1960	-19.45	-17.62	-15.65	-4.36	7.84	14.42	16.41	16.75	9.94	2.60	-7.49	-19.75
1961	-23.16	-17.24	-11.30	-2.70	5.27	13.03	18.57	16.46	9.49	2.49	-5.93	-18.45
1962	-25.55	-23.56	-9.80	-4.68	6.28	15.24	16.73	14.65	8.71	4.78	-6.11	-19.50
1963	-25.56	-21.93	-14.47	-1.49	4.85	14.10	19.08	15.00	8.77	9.00	-5.76	-19.40
1964	-19.05	-16.60	-17.90	-2.09	8.22	12.49	17.65	12.67	8.74	2.78	-7.63	-21.65
1965	-23.32	-22.80	-15.79	-1.69	6.21	13.10	13.85	12.44	7.10	2.42	-9.42	-14.98
1966	-23.79	-18.15	-10.99	-2.90	3.72	14.00	17.76	14.80	10.65	1.07	-12.97	-19.29
1967	-22.97	-24.96	-13.10	-5.62	2.08	13.88	16.39	15.49	12.48	1.92	-8.14	-15.67
1968	-22.90	-20.46	-8.94	-0.73	8.09	12.85	14.61	13.43	13.67	3.41	-7.56	-16.56
1969	-19.92	-16.38	-15.16	-0.20	4.23	8.78	17.30	17.81	7.32	-0.02	-6.90	-13.82
1970	-23.07	-23.01	-11.31	-3.09	3.96	14.29	18.15	16.24	9.46	5.29	-6.30	-21.39
1971	-22.81	-16.48	-12.47	-1.76	5.47	14.61	14.75	14.88	10.67	5.11	-7.35	-17.63
1972	-26.53	-24.16	-14.66	-3.33	8.04	14.69	15.28	15.65	7.48	-0.25	-10.04	-23.91
1973	-18.78	-19.62	-6.49	-3.86	5.31	13.03	17.04	18.33	9.22	5.63	-7.00	-20.74
1974	-26.54	-21.66	-16.43	-4.12	2.83	12.68	18.17	14.18	6.22	0.00	-4.94	-12.80
1975	-22.02	-17.59	-12.92	-3.27	9.05	15.64	17.37	15.10	8.70	3.48	-4.84	-19.72
1976	-23.91	-17.13	-15.29	-0.13	5.88	15.39	17.57	16.44	9.43	1.35	-8.46	-25.74
1977	-22.55	-17.75	-7.07	0.57	11.04	13.37	16.34	12.63	9.75	5.29	-5.02	-18.89
1978	-22.70	-18.04	-13.97	-3.30	8.11	11.19	16.42	14.07	7.88	2.20	-9.24	-21.32
1979	-23.39	-24.10	-11.99	-1.64	5.90	13.86	17.60	13.17	7.83	0.47	-7.83	-13.61
1980	-21.87	-20.75	-12.57	-0.33	9.44	12.54	17.60	16.50	6.95	-0.56	-7.87	-20.26
1981	-17.78	-13.76	-7.14	-4.41	5.77	12.59	19.25	17.76	8.80	1.86	-1.69	-16.21
1982	-26.76	-19.75	-12.21	-5.16	9.35	10.62	17.31	13.19	9.65	3.71	-7.72	-16.28
1983	-19.32	-17.66	-12.32	-2.62	2.59	14.94	19.28	18.68	11.43	4.27	-4.13	-22.66
1984	-24.56	-12.36	-14.03	3.45	6.35	14.05	17.95	18.85	7.90	4.47	-6.51	-19.58
1985	-22.32	-20.36	-9.74	-2.75	6.51	12.03	15.71	15.17	9.37	3.25	-11.74	-20.61
1986	-21.84	-18.84	-10.56	0.59	10.18	12.08	17.05	15.30	7.54	1.60	-13.74	-12.26
1987	-15.32	-14.07	-7.60	3.51	9.41	14.92	17.01	14.62	11.64	0.52	-5.64	-10.80
1988	-23.47	-22.04	-11.56	0.53	8.89	15.10	18.38	16.87	9.64	1.29	-5.52	-19.86

Basin: Albany River
Station: Fort Albany

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1987	-16.85	-19.72	-11.13	-0.87	7.96	10.42	12.59	12.02	9.12	0.68	-6.06	-7.55
1988	-25.85	-24.34	-12.26	-1.47	6.92	9.07	17.41	14.67	10.24	2.10	-2.41	-18.76

Basin: Moose River
Station: Moosonee

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1982	-25.23	-20.61	-11.31	-5.89	8.00	11.59	14.73	12.27	10.01	5.72	-5.41	-14.58
1983	-18.66	-17.69	-12.69	-3.86	2.90	14.56	15.33	15.23	10.67	4.39	-1.66	-19.71
1984	-23.92	-12.46	-15.10	1.41	4.88	11.30	15.94	15.34	8.33	5.47	-3.61	-17.22
1985	-20.76	-19.10	-11.51	-3.10	4.99	11.53	13.44	14.53	10.67	4.73	-7.60	-19.92
1986	-21.58	-18.46	-12.25	0.06	7.50	9.85	14.73	13.75	7.54	2.01	-9.18	-11.16
1987	-14.35	-17.29	-9.03	1.59	7.79	12.40	15.01	14.36	10.65	1.84	-5.45	-9.14
1988	-21.36	-21.74	-12.04	-1.20	7.16	9.79	15.98	14.42	10.17	1.89	-1.91	-18.76
1989	-19.84	-19.65	-14.97	-3.29	7.15	11.88	14.87	13.18	11.00	4.41	-10.13	-22.87
1990	-18.32	-18.74	-8.19	-2.68	4.36	11.43	16.85	14.50	7.86	2.96	-3.43	-16.72
1991	-24.62	-14.36	-11.47	-0.31	7.09	12.84	15.27	15.10	8.73	2.73	-4.72	-16.79
1992	-19.25	-21.07	-15.81	-4.28	6.87	9.27	12.13	12.33	10.51	1.43	-5.13	-15.31
1993	-18.35	-21.69	-10.11	-2.34	7.91	13.45	16.91	16.14	8.35	1.35	-7.34	-5.28

Basin: Upper Ottawa River
Station: Lake Traverse

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1966	-13.51	-8.94	-3.16	2.98	7.84	16.63	19.59	17.38	11.45	6.33	1.05	-9.65
1967	-8.52	-15.93	-6.22	2.81	7.21	17.98	18.75	16.45	12.50	6.24	-1.79	-7.06
1968	-14.75	-12.89	-1.56	6.12	10.11	16.09	18.84	16.69	15.01	8.93	-1.45	-10.14
1969	-10.39	-7.45	-5.35	4.21	9.06	14.75	18.21	19.06	13.02	6.39	1.00	-10.19
1970	-15.41	-10.32	-5.65	3.53	10.21	15.71	19.18	17.89	12.98	7.57	0.80	-12.43
1971	-15.29	-9.91	-6.54	2.40	11.42	16.53	17.46	16.95	15.07	10.63	-1.27	-8.52
1972	-11.01	-14.44	-8.39	0.50	11.67	14.73	18.47	16.34	12.68	4.15	-1.62	-10.63
1973	-10.11	-14.69	0.84	3.94	10.08	17.49	19.47	19.93	12.94	9.10	-1.00	-8.69
1974	-11.35	-13.97	-6.34	4.01	8.66	16.32	18.39	17.66	11.16	4.78	-0.01	-4.82
1975	-9.76	-9.14	-6.43	0.43	14.06	17.47	19.96	18.42	11.84	7.43	2.51	-11.24
1976	-16.95	-8.19	-4.88	5.74	9.44	18.30	17.94	16.72	12.03	3.76	-3.10	-14.87
1977	-15.79	-9.13	0.11	5.09	13.74	14.86	19.04	15.84	12.31	5.28	0.38	-11.27
1978	-14.30	-15.75	-7.12	0.58	13.27	15.57	18.87	17.70	11.22	5.35	-0.90	-9.30
1979	-13.78	-16.52	-1.62	3.07	11.68	16.46	19.25	16.79	12.86	5.99	1.09	-6.56
1980	-10.86	-12.52	-4.60	5.40	11.92	13.29	18.65	18.62	11.26	4.39	-2.09	-14.72
1981	-16.00	-4.38	-2.20	5.26	10.54	16.54	19.21	17.24	12.21	4.38	0.29	-6.31
1982	-17.89	-11.48	-5.04	2.12	13.62	14.44	18.83	15.20	13.19	7.94	0.57	-4.91
1983	-10.39	-9.33	-2.50	3.08	9.01	17.04	20.16	19.14	14.67	6.35	-0.89	-11.37
1984	-14.66	-4.77	-8.43	6.08	9.36	16.84	18.38	18.74	11.67	8.23	-0.20	-6.28
1985	-15.57	-9.22	-3.43	3.21	11.48	14.35	17.98	16.75	13.93	7.54	-0.94	-11.28
1986	-11.70	-11.24	-2.62	7.27	13.13	14.83	18.43	16.24	11.83	6.45	-1.93	-5.86

Basin: Upper Ottawa River
Station: New Liskeard

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1967	-12.80	-18.53	-8.68	1.08	6.49	16.53	17.60	15.35	12.44	5.88	-3.63	-8.92
1968	-16.86	-16.55	-4.65	5.24	9.97	14.38	18.13	15.87	14.42	9.04	-3.80	-9.76
1969	-11.20	-11.81	-9.30	1.28	8.94	14.09	18.11	18.95	11.18	4.80	-0.92	-11.41
1970	-19.83	-16.40	-7.46	1.75	8.32	15.32	19.86	18.35	12.20	8.76	-1.16	-14.40
1972	-15.60	-16.41	-11.40	-0.31	11.36	14.73	17.80	15.75	11.14	3.42	-2.87	-14.02
1973	-11.91	-16.18	-0.61	2.88	9.16	16.58	19.07	19.58	12.16	8.20	-2.43	-11.69
1977	-18.57	-12.14	-3.08	2.56	12.88	13.85	18.65	15.33	10.58	4.76	0.23	-11.23
1978	-18.10	-15.60	-10.03	-1.57	12.94	13.98	18.03	17.03	10.25	6.27	-4.40	-13.37
1979	-18.43	-20.29	-4.95	0.71	10.40	15.91	18.51	14.36	12.21	5.05	-0.69	-8.77
1982	-22.27	-16.63	-6.95	-1.54	12.57	12.70	19.71	13.79	10.95	8.17	-1.21	-6.66
1983	-14.06	-13.62	-5.44	2.41	7.34	15.84	19.53	17.15	12.08	5.11	-0.47	-17.36

Table 3. **Monthly and annual precipitation and snowmelt at the Big Trout Lake meteorological station in the Severn River drainage basin.**

(All values in mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1939													
Precipitation	-	0.3	22.1	39.4	39.1	113.5	55.5	24.1	96.9	63.8	29.1	-	483.8
Rain	-	0	0	0.8	38.1	113.5	55.5	24.1	84.2	7.9	0.8	-	324.9
Snow	-	0.3	22.1	38.6	1	0	0	0	12.7	55.9	28.3	-	158.9
Snow Melt and Rain	-	0	0.8	61	39.1	113.5	55.5	24.1	96.9	7.9	10.1	-	408.91
1940													
Precipitation	56	20.1	23.6	25.1	29	100.5	165	91.8	9	52.8	21	2.5	596.3
Rain	0	0	0	15.2	22.6	96.7	165	91.8	9	51.5	13.4	0	465.1
Snow	56	20.1	23.6	9.9	6.4	3.8	0	0	0	1.3	7.6	2.5	131.2
Snow Melt and Rain	0	0	0	39.18	136	100.5	165	91.8	9	52.8	13.4	0	607.39
1941													
Precipitation	30.9	30.6	9	21.7	70.5	76.6	16.2	51	134.4	34.8	-	62.5	538.2
Rain	0	0	0	3.8	48.1	76.6	16.2	51	134.4	24.6	-	0	354.7
Snow	30.9	30.6	9	17.9	22.4	0	0	0	0	10.2	-	62.5	183.5
Snow Melt and Rain	0	0	0	93.1	72.2	76.6	16.2	51	134.4	31.2	-	0	474.7
1942													
Precipitation	56.6	21.3	20.2	21.2	65	89.1	48.6	96.9	59.5	57.8	101	53.3	690.1
Rain	0	0	0	3	26.9	89.1	48.6	96.9	59.5	32.7	0	0	356.7
Snow	56.6	21.3	20.2	18.2	38.1	0	0	0	0	25.1	101	53.3	333.4
Snow Melt and Rain	0	0	3.3	182.1	65	89.1	48.6	96.9	59.5	32.7	0	0	577.2
1943													
Precipitation	25.2	31.7	19.6	22.1	40.9	78.1	106	82.6	166.3	28.5	20.6	11	632.8
Rain	0	0	0	8.9	27.2	78.1	106	82.6	166.3	23.4	0	0	492.7
Snow	25.2	31.7	19.6	13.2	13.7	0	0	0	0	5.1	20.6	11	140.1
Snow Melt and Rain	0	0	0	87.87	231	78.1	106	82.6	166.3	28.5	0	0	780.2
1944													
Precipitation	27.1	48.1	13.1	7.9	22.8	89.7	117	110.1	46.3	24.4	62	35	603.5
Rain	0	0	0	4.8	19.5	89.7	117	110.1	27.7	13.7	0	0	382.5
Snow	27.1	48.1	13.1	3.1	3.3	0	0	0	18.6	10.7	62	35	221
Snow Melt and Rain	0	0	0	127.8	22.8	89.7	117	110.1	27.7	42.5	0	0	537.6
1945													

Precipitation	13.9	20.2	38.7	60.4	96.9	135	73.1	99	49.3	51.9	104	12	754.5
Rain	0	0	6.9	6.1	13.5	135	73.1	99	49.3	32.8	0	0	415.7
Snow	13.9	20.2	31.8	54.3	83.4	0	0	0	0	19.1	104	12	338.8
Snow Melt and Rain	0	0	38.5	14.65	156	253.8	73.1	99	49.3	37.9	0	0	721.9
1946													
Precipitation	43.1	24.6	25.2	38.4	10.2	68.9	70.2	124	90.8	70.1	64.4	25.9	655.8
Rain	0	0	0	0.3	6.4	68.9	70.2	124	90.8	24.9	1.8	0	387.3
Snow	43.1	24.6	25.2	38.1	3.8	0	0	0	0	45.2	62.6	25.9	268.5
Snow Melt and Rain	0	0	5.1	82.81	184	68.9	70.2	124	90.8	50.5	26	0	702.02
1947													
Precipitation	47.2	50.9	20.6	22.2	53.1	23.9	111	208.5	70.7	79	43.5	11.7	742.3
Rain	0	0	0	0	32.3	23.9	111	208.5	70.7	79	21.6	0	547
Snow	47.2	50.9	20.6	22.2	20.8	0	0	0	0	0	21.9	11.7	195.3
Snow Melt and Rain	0	0	0	0	152	149.3	111	208.5	70.7	79	21.6	0	792.58
1948													
Precipitation	2.1	11.6	5.9	53.8	17.7	27.1	201	43.2	46.1	31.9	34.2	28.9	503.3
Rain	0	0	0	48.8	17.7	27.1	201	43.2	46.1	28.1	28	0	439.8
Snow	2.1	11.6	5.9	5	0	0	0	0	0	3.8	6.2	28.9	63.5
Snow Melt and Rain	0	0	0	107	17.7	27.1	201	43.2	46.1	31.9	28	0	501.8
1949													
Precipitation	9.2	14.8	6.9	22.1	67.1	84.5	160	94.2	86.9	82.3	43.9	39.6	711.5
Rain	0	0	0	0	40.4	84.5	160	94.2	86.9	42	0	0	508
Snow	9.2	14.8	6.9	22.1	26.7	0	0	0	0	40.3	43.9	39.6	203.5
Snow Melt and Rain	0	0	0	79.2	76	84.5	160	94.2	86.9	42.3	2.7	0	625.8
1950													
Precipitation	16.1	19.8	7.5	38.9	31.6	51.7	84.6	90.9	15	60.7	43.4	37.4	497.6
Rain	0	0	0	0	4.9	51.7	84.6	90.9	15	35.8	0	0	282.9
Snow	16.1	19.8	7.5	38.9	26.7	0	0	0	0	24.9	43.4	37.4	214.7
Snow Melt and Rain	0	0	0	3.3	231	51.7	84.6	90.9	15	60.7	0	0	537.6
1951													
Precipitation	19.1	7.4	18.5	19.1	37.9	37.4	135	108.3	85.5	68.4	42.9	40	619.2
Rain	0	0.8	0	9.9	26	37.4	135	108.3	85.5	45.8	0	2.5	450.9
Snow	19.1	6.6	18.5	9.2	11.9	0	0	0	0	22.6	42.9	37.5	168.3
Snow Melt and Rain	0	2.61	5.1	106.1	69	37.4	135	108.3	85.5	45.8	0	4.32	598.82
1952													
Precipitation	30.2	21.9	7	19.5	67.9	139.9	179	147.6	91.1	65.9	39.4	38.3	847.4

Rain		0	0	0.5	6.4	56.2	139.9	179	147.6	91.1	20.8	2.8	0	644
Snow		30.2	21.9	6.5	13.1	11.7	0	0	0	0	45.1	36.6	38.3	203.4
Snow Melt and Rain		0	0	1.4	178.4	65.5	142.3	179	147.6	91.1	48.2	11.2	0	864.39
	1953													
Precipitation		34.2	22.9	15.6	-	-	102.2	94.6	29.7	87.2	57	33.2	44.9	521.5
Rain		0	0	0	-	-	102.2	94.6	29.7	87.2	54.1	0	0	367.8
Snow		34.2	22.9	15.6	-	-	0	0	0	0	2.9	33.2	44.9	153.7
Snow Melt and Rain		0	0	0	-	-	245.6	94.6	29.7	87.2	54.1	23	0	534.19
	1954													
Precipitation		13.8	28.6	21.7	39.3	58.6	76.3	62	60.5	69.2	29.5	46.7	26.1	532.3
Rain		0	0	0	21.6	30.6	76.3	62	60.5	69.2	20.7	0	0	340.9
Snow		13.8	28.6	21.7	17.7	28	0	0	0	0	8.8	46.7	26.1	191.4
Snow Melt and Rain		0	0	0	38.85	181	76.3	62	60.5	69.2	20.7	4.2	0	512.9
	1955													
Precipitation		15.4	24.5	24.5	18.4	48.3	86.1	137	169.6	98.3	58.5	58.1	11.3	750.4
Rain		0	0	0	13.1	46.5	86.1	137	169.6	98.3	48.8	5.6	0	605.4
Snow		15.4	24.5	24.5	5.3	1.8	0	0	0	0	9.7	52.5	11.3	145
Snow Melt and Rain		0	0	0.9	159.3	48.3	86.1	137	169.6	98.3	51.8	8.98	0	760.71
	1956													
Precipitation		14.2	7.9	9.9	9.1	42.1	19.8	52.4	75.3	62.2	59.8	49.9	21	423.6
Rain		0	0	0	1.5	27.1	19.8	52.4	75.3	62.2	36.7	7.1	0	282.1
Snow		14.2	7.9	9.9	7.6	15	0	0	0	0	23.1	42.8	21	141.5
Snow Melt and Rain		0	0	0	12.62	138	19.8	52.4	75.3	62.2	36.7	30.2	0	426.89
	1957													
Precipitation		19.2	12.1	19.3	16.5	43.4	99.1	68.4	98.5	28.6	44.1	35.5	40.7	525.4
Rain		0	0	0	13.4	41.4	99.1	68.4	98.5	28.6	29.6	1	0	380
Snow		19.2	12.1	19.3	3.1	2	0	0	0	0	14.5	34.5	40.7	145.4
Snow Melt and Rain		0	0	0	130.9	43.4	99.1	68.4	98.5	28.6	40.8	2.81	0	512.53
	1958													
Precipitation		23.8	14.9	15.7	36.6	34.6	55.8	76.8	56.1	73.9	30.5	40.3	20.7	479.7
Rain		0	0	0	8.9	25.9	55.8	76.8	56.1	73.9	27.2	1.1	0	325.7
Snow		23.8	14.9	15.7	27.7	8.7	0	0	0	0	3.3	39.2	20.7	154
Snow Melt and Rain		0	0	0	78.06	124	55.8	76.8	56.1	73.9	30.5	1.1	0	496.47
	1959													
Precipitation		14.5	12.5	18.8	20.8	82	70.9	122	90.6	106.9	50.8	45.3	24.4	659.7
Rain		0	0	0	1.5	55.9	70.9	122	90.6	105.1	12.3	0	0	458.5

Snow		14.5	12.5	18.8	19.3	26.1	0	0	0	1.8	38.5	45.3	24.4	201.2
Snow Melt and Rain		0	0	0	7.53	201	70.9	122	90.6	105.1	25.2	0	0	622.54
	1960													
Precipitation		15.3	9.1	7.6	12.8	39.2	32	69.4	71.4	49.3	55.8	29.3	11.3	402.5
Rain		0	0	0	4.8	34.9	32	69.4	71.4	49.3	32.6	0	0	294.4
Snow		15.3	9.1	7.6	8	4.3	0	0	0	0	23.2	29.3	11.3	108.1
Snow Melt and Rain		0	0	0	31.58	149	32	69.4	71.4	49.3	42.5	0	0	445.67
	1961													
Precipitation		17.6	10.9	17.2	12.2	13.2	13.5	66.2	41.8	89.1	95.3	24.6	41.7	443.3
Rain		0	0	0	4.3	11.7	13.5	66.2	41.8	89.1	64.2	0	0	290.8
Snow		17.6	10.9	17.2	7.9	1.5	0	0	0	0	31.1	24.6	41.7	152.5
Snow Melt and Rain		0	0	7.5	64.53	53	13.5	66.2	41.8	89.1	70	0	0	405.59
	1962													
Precipitation		6.3	10.7	7.4	24.9	58.9	46.2	96.8	20.7	54.7	63.3	36.1	22.9	448.9
Rain		0	0	0	0	54.3	46.2	96.8	20.7	54.7	58.9	0	0	331.6
Snow		6.3	10.7	7.4	24.9	4.6	0	0	0	0	4.4	36.1	22.9	117.3
Snow Melt and Rain		0	0	0	29.4	168	49	96.8	20.7	54.7	62.5	7.5	0	488.2
	1963													
Precipitation		21	14.4	41.5	47.9	43.2	50.8	57.5	40	51.2	38.7	63.1	12.1	481.4
Rain		0	0	0	12.7	20.8	50.8	57.5	40	51.2	38.7	15	0	286.7
Snow		21	14.4	41.5	35.2	22.4	0	0	0	0	0	48.1	12.1	194.7
Snow Melt and Rain		0	0	1.8	77.3	141	50.8	57.5	40	51.2	38.7	17.8	0	476.3
	1964													
Precipitation		35.3	23	28	49.2	76.6	55	84.9	85.9	63.2	53.4	45.1	31.8	631.4
Rain		0	0	0	9.5	68.7	55	84.9	85.9	59.1	31.5	7.4	0	402
Snow		35.3	23	28	39.7	7.9	0	0	0	4.1	21.9	37.7	31.8	229.4
Snow Melt and Rain		0	0	0	163	107	55	84.9	85.9	63.2	53.4	7.7	0	619.6
	1965													
Precipitation		47.6	48	17.8	21.5	105	84.5	109	74.5	63.3	71	42.2	33.8	717.4
Rain		0	0	0	3.9	78.6	84.5	109	74.5	51.9	61.7	0	0	463.8
Snow		47.6	48	17.8	17.6	25.9	0	0	0	11.4	9.3	42.2	33.8	253.6
Snow Melt and Rain		0	0	0	81.43	227	84.5	109	74.5	63.3	69.5	0	0	709.1
	1966													
Precipitation		33.1	20.2	35.1	35.5	29	111.8	112	100.6	77.5	68.9	15.5	33.2	672.4
Rain		0	0	0	0.3	20.3	111.8	112	100.6	77.2	38.7	0	0	460.9
Snow		33.1	20.2	35.1	35.2	8.7	0	0	0	0.3	30.2	15.5	33.2	211.5

Snow Melt and Rain	0	0	0	55.81	175	111.8	112	100.6	77.5	59.8	0	0	692.1
1967													
Precipitation	30.4	14.1	44.3	67.3	34.5	28.9	58.7	65.4	39.7	50.1	31.8	42.9	508.1
Rain	0	0	0	7.1	17.5	28.9	58.7	65.4	39.7	38.2	0	0	255.5
Snow	30.4	14.1	44.3	60.2	17	0	0	0	0	11.9	31.8	42.9	252.6
Snow Melt and Rain	0	0	0	13.28	235	28.9	58.7	65.4	39.7	49.9	0	0	491.03
1968													
Precipitation	28.6	25.9	11.8	8.2	37.9	50.4	116	97.5	53.1	69.1	20.6	8.8	527.5
Rain	0	0	2.9	7.1	37.9	50.4	116	97.5	53.1	63.9	0	0	428.4
Snow	28.6	25.9	8.9	1.1	0	0	0	0	0	5.2	20.6	8.8	99.1
Snow Melt and Rain	0	0	36.9	112.5	37.9	50.4	116	97.5	53.1	69.1	0	0	572.97
1969													
Precipitation	66	4.9	24.6	8.7	50.1	48.5	62	73.3	136.1	39.2	58.3	32.1	603.8
Rain	0	0	0	1.8	40.4	48.5	62	73.3	136.1	27.2	1	0	390.3
Snow	66	4.9	24.6	6.9	9.7	0	0	0	0	12	57.3	32.1	213.5
Snow Melt and Rain	0	0	0	133.6	50.1	48.5	62	73.3	136.1	35.6	4.89	0	544.1
1970													
Precipitation	23.5	18.2	20.9	47.5	48	94	108	85.6	88.3	58.4	36.4	42.7	671
Rain	0	0	0	7.6	47	94	108	85.6	88.3	18	2.8	0	450.8
Snow	23.5	18.2	20.9	39.9	1	0	0	0	0	40.4	33.6	42.7	220.2
Snow Melt and Rain	0	0	7.5	70.1	170	94	108	85.6	88.3	58.4	3.9	0	684.9
1971													
Precipitation	22.9	42.9	7.6	59.9	40.6	39.5	96	42.7	46.5	130	46.3	58.4	633.4
Rain	0	0	0	15.9	10.6	39.5	96	42.7	46.5	76	0	0	327.2
Snow	22.9	42.9	7.6	44	30	0	0	0	0	54.1	46.3	58.4	306.2
Snow Melt and Rain	0	0	0	110.7	138	39.5	96	42.7	46.5	90.5	0	0	564.3
1972													
Precipitation	14.4	7.9	6.6	6.3	37.6	49.5	54.9	52.6	108.4	35.2	25.3	28.3	427
Rain	0	0	0	3.6	34.5	46.5	54.9	52.6	107.1	5.6	0	0	304.8
Snow	14.4	7.9	6.6	2.7	3.1	3	0	0	1.3	29.6	25.3	28.3	122.2
Snow Melt and Rain	0	0	15.3	129.4	72.5	49.5	54.9	52.6	108.4	17.1	0	0	499.62
1973													
Precipitation	26.6	36.1	46.5	82.9	11.7	96.8	69.2	70.5	130.2	61	87.5	25	744
Rain	0	0	0.3	6.9	7.4	96.8	69.2	70.5	130.2	38.3	0	0	419.6
Snow	26.6	36.1	46.2	76	4.3	0	0	0	0	22.7	87.5	25	324.4
Snow Melt and Rain	0	0	8.4	37.12	230	96.8	69.2	70.5	130.2	60.5	0	0	702.68

1974													
Precipitation	12.7	17	32.1	6.4	46	120.3	60.5	138.1	62.1	11.7	54.8	27.7	589.4
Rain	0	0	0	2.3	43.7	120.3	60.5	138.1	53.4	2.8	0	0	421.1
Snow	12.7	17	32.1	4.1	2.3	0	0	0	8.7	8.9	54.8	27.7	168.3
Snow Melt and Rain	0	0	0	74.81	152	120.3	60.5	138.1	54.2	17.8	9	0	627.1
1975													
Precipitation	39.4	23.7	23	4.4	57.8	64.1	194	130.5	39.7	57.5	20.8	32	687.2
Rain	0	0	0	0.3	46.4	64.1	194	130.5	39.7	13.8	0.8	0	489.9
Snow	39.4	23.7	23	4.1	11.4	0	0	0	0	43.7	20	32	197.3
Snow Melt and Rain	0	0	8.4	92.11	123	64.1	194	130.5	39.7	19.7	47.3	0	719.2
1976													
Precipitation	31.1	24.1	13.5	53.2	29	87.4	93.6	65	22.9	16.3	42.4	36	514.5
Rain	0	0	4.3	10.7	12.5	87.4	93.6	65	20.9	3.9	0	0	298.3
Snow	31.1	24.1	9.2	42.5	16.5	0	0	0	2	12.4	42.4	36	216.2
Snow Melt and Rain	0	0	7.05	121.5	65.7	87.4	93.6	65	22.9	16.3	0	0	479.4
1977													
Precipitation	36.1	29.3	26.2	29.3	26.8	30.8	122	118.7	45.1	47.2	56	17.9	585.2
Rain	0	0	0.8	12.1	25.6	30.8	122	118.7	45.1	47.2	3.4	0	405.5
Snow	36.1	29.3	25.4	17.2	1.2	0	0	0	0	0	52.6	17.9	179.7
Snow Melt and Rain	0	0	1.1	198.2	26.8	30.8	122	118.7	45.1	47.2	3.4	0	593.1
1978													
Precipitation	10.5	16	39.4	37	13.8	84.4	112	88.7	64.7	70.1	28.8	16.7	582.3
Rain	0	0	0	2	13.8	84.4	112	88.7	64.7	41.6	0.6	0	408
Snow	10.5	16	39.4	35	0	0	0	0	0	28.5	28.2	16.7	174.3
Snow Melt and Rain	0	0	0	48.5	139	84.4	112	88.7	64.7	70.1	7.81	0	615.11
1979													
Precipitation	11.2	13.9	26.4	21.9	63.5	35.7	101	82.3	64.7	61	65.2	22.7	569
Rain	0	0	10	13	43.1	35.7	101	82.3	64.7	37.4	3.9	0	390.6
Snow	11.2	13.9	16.4	8.9	20.4	0	0	0	0	23.6	61.3	22.7	178.4
Snow Melt and Rain	0	0	28.5	79.4	66.7	35.7	101	82.3	64.7	45.5	4.2	0	507.49
1980													
Precipitation	34	9.6	22.6	7.7	21.9	63.5	74.2	80	155.7	60.7	18.5	36.9	585.3
Rain	0	0	0.2	2.2	20.2	63.5	74.2	80	134	2.2	0.7	0	377.2
Snow	34	9.6	22.4	5.5	1.7	0	0	0	21.7	58.5	17.8	36.9	208.1
Snow Melt and Rain	0	0	2.9	170.2	21.9	63.5	74.2	80	136.9	27.7	2.2	0	579.5

	1981												
Precipitation	10	22.2	22.9	13.6	23.9	86.5	82.3	97.2	150.9	35.5	45.3	21.5	611.8
Rain	0	0	1.8	1.4	22.3	86.5	82.3	97.2	150.9	27.9	0.7	0	471
Snow	10	22.2	21.1	12.2	1.6	0	0	0	0	7.6	44.6	21.5	140.8
Snow Melt and Rain	0	4.2	9.32	27.84	156	86.5	82.3	97.2	150.9	35.5	9.8	0	659.8
	1982												
Precipitation	23.9	20.6	47.5	37.2	35.6	107.3	139	124.8	33.2	57.5	29.3	61.3	717.2
Rain	0	0	2.8	0.4	34.4	93.7	139	124.8	33.2	50.1	8.7	14.8	501.9
Snow	23.9	20.6	44.7	36.8	1.2	13.6	0	0	0	7.4	20.6	46.5	215.3
Snow Melt and Rain	0	0	10.1	83.21	129	107.3	139	124.8	33.2	57.5	9.63	16.7	709.94
	1983												
Precipitation	26.6	19	27.7	14.6	39.7	117.4	76.8	112.6	83.3	47.6	89.8	17.8	672.9
Rain	0	0	0	0.8	15.6	117.4	76.8	112.6	83.3	45.2	10.8	0	462.5
Snow	26.6	19	27.7	13.8	24.1	0	0	0	0	2.4	79	17.8	210.4
Snow Melt and Rain	0	0	0	44.34	148	117.4	76.8	112.6	83.3	47.6	12	0	641.56
	1984												
Precipitation	20.6	25.6	4.7	23	22.7	135.5	90.3	85.8	75.8	62.8	95.1	35.2	677.1
Rain	0	0	0	22.8	21.7	135.5	90.3	85.8	69.3	25	0	0	450.4
Snow	20.6	25.6	4.7	0.2	1	0	0	0	6.5	37.8	95.1	35.2	226.7
Snow Melt and Rain	0	0	0	169.3	22.9	135.5	90.3	85.8	75.8	29.6	0	0	609.16
	1985												
Precipitation	21.5	14.8	25.2	40.5	50.2	153	78	55	126.1	37.3	24	29	654.6
Rain	0	0	1.6	31.6	50.2	153	78	55	126.1	7.4	5.8	0	508.7
Snow	21.5	14.8	23.6	8.9	0	0	0	0	0	29.9	18.2	29	145.9
Snow Melt and Rain	0	0	5.5	202.8	107	153	78	55	126.1	37.3	5.8	0	770.94
	1986												
Precipitation	19.9	16.7	60.4	96.4	31.1	73.6	90.3	64.6	142.4	60.8	57.8	25.8	739.8
Rain	0	0	2	42.6	25.7	73.6	90.3	64.6	142.4	33.5	0	0	474.7
Snow	19.9	16.7	58.4	53.8	5.4	0	0	0	0	27.3	57.8	25.8	265.1
Snow Melt and Rain	0	0	4.41	138.2	129	73.6	90.3	64.6	142.4	42.6	0	0	685.2
	1987												
Precipitation	25.1	26.6	21.6	30.7	33.5	82.8	51.3	141.2	52.9	83.2	34.9	31.6	615.4
Rain	0	0	5.8	28.9	32.5	82.8	51.3	141.2	52.9	53.4	5.4	1	455.2
Snow	25.1	26.6	15.8	1.8	1	0	0	0	0	29.8	29.5	30.6	160.2
Snow Melt and Rain	0	0	61.1	144.2	34	82.8	51.3	141.2	52.9	68.6	11.8	5.51	653.42
	1988												

Precipitation	29.3	18.4	54.2	24.2	48.9	34.8	115	21.2	104.6	32.1	64.4	25.8	573.1
Rain	0	0	0	3.2	48.3	34.8	115	21.2	104.6	13.3	0.2	0	340.8
Snow	29.3	18.4	54.2	21	0.6	0	0	0	0	18.8	64.2	25.8	232.3
Snow Melt and Rain	0	0	0	159.2	79.6	34.8	115	21.2	104.6	18.7	1.4	0	534.69
1989													
Precipitation	29.5	20.8	20	7.8	70.8	33.2	41.8	74.4	83.2	41.6	41.6	19.2	483.9
Rain	0	0	0	0	63.2	33.2	41.8	74.4	83.2	18.2	0	0	314
Snow	29.5	20.8	20	7.8	7.6	0	0	0	0	23.4	41.6	19.2	169.9
Snow Melt and Rain	0	0	0	45.6	206	33.2	41.8	74.4	83.2	41.2	0	0	524.9
1990													
Precipitation	31.8	19.4	42.1	56.6	3.6	43.6	74.4	141.4	35.2	45.4	58.5	26.4	578.4
Rain	0	0.6	0	15.3	2.6	43.6	74.4	141.4	35.2	23.6	20.4	0	357.1
Snow	31.8	18.8	42.1	41.3	1	0	0	0	0	21.8	38.1	26.4	221.3
Snow Melt and Rain	0	24.36	25.2	85.32	79.8	43.6	74.4	141.4	35.2	40.6	39.4	0	589.26
1991													
Precipitation	17.8	8.8	24.6	31.2	47.2	44.6	106	52.8	108.5	62.2	66	10.2	579.5
Rain	0	0	0	29.2	41.8	44.6	106	52.8	108.5	15.4	3.8	0	401.7
Snow	17.8	8.8	24.6	2	5.4	0	0	0	0	46.8	62.2	10.2	177.8
Snow Melt and Rain	0	2.1	0	130.6	47.2	44.6	106	52.8	108.5	19	18	0	528.49
1992													
Precipitation	19.8	19.7	19.4	22.8	75.8	49.8	78.2	91.4	89	9.8	-	-	475.7
Rain	0.4	0	1	0	52.4	49.8	78.2	91.4	88.2	9.8	-	-	371.2
Snow	19.4	19.7	18.4	22.8	23.4	0	0	0	0.8	0	-	-	104.5
Snow Melt and Rain	1.3	0	2.2	53.7	202	49.8	78.2	91.4	89	9.8	-	-	577.05

Table 4. Monthly and annual precipitation and snowmelt at the Winisk meteorological station in the Winisk River drainage basin.

(All values in mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1969													
Precipitation	28.4	9.1	-	4.6	45.4	20.2	46.8	80.9	56.2	36.2	65.6	13.2	406.6
Rain	0	0	-	0	2	20.2	46.8	80.9	56.2	19.5	18.8	0	244.4
Snow	28.4	9.1	-	4.6	43.4	0	0	0	0	16.7	46.8	13.2	162.2
Snow Melt and Rain	0	0	-	22.5	57.51	82.88	46.8	80.9	56.2	23.74	32.06	0	402.59
1970													
Precipitation	12.7	4.6	4.6	29.2	36	98.1	55.7	84.4	56.8	48.5	22.9	17.9	471.4
Rain	0	0	0	0	14.4	89.5	55.7	84.4	56.8	48.5	3.8	0	353.1
Snow	12.7	4.6	4.6	29.2	21.6	8.6	0	0	0	0	19.1	17.9	118.3
Snow Melt and Rain	0	0	0	1.8	96.72	145.88	55.7	84.4	56.8	48.5	3.8	0	493.6
1971													
Precipitation	16.8	37.5	10.2	38.2	22.9	63.7	-	-	2.6	-	-	-	191.9
Rain	0	0	0	12.8	21.6	63.7	-	-	2.6	-	-	-	100.7
Snow	16.8	37.5	10.2	25.4	1.3	0	-	-	0	-	-	-	91.2
Snow Melt and Rain	0	0	0	37.53	125.07	63.7	-	-	2.6	-	-	-	228.9

Table 5. Monthly and annual precipitation and snowmelt at the Lansdowne House meteorological station in the Attawapiskat River drainage basin.

(All values in mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1941													
Precipitation	-	-	9.9	26.8	69	64.4	78.3	40.3	155	45.9	26.7	54.5	570.8
Rain	-	-	0	5.5	69	64.4	78.3	40.3	155	18.5	0	2.5	433.5
Snow	-	-	9.9	21.3	0	0	0	0	0	27.4	26.7	52	137.3
Snow Melt and Rain	-	-	0	20.8	84.9	64.4	78.3	40.3	155	35.7	0	7.65	487.05
1942													
Precipitation	38.4	24.4	29.5	54.5	48.3	51.8	88.5	73.7	53.8	34.4	42	26.8	566.1
Rain	0	0	0	45.7	17	51.8	88.5	73.7	53.8	19.4	0.3	0	350.2
Snow	38.4	24.4	29.5	8.8	31.3	0	0	0	0	15	41.7	26.8	215.9
Snow Melt and Rain	0	0	3.3	227.3	48.3	51.8	88.5	73.7	53.8	19.4	3	0	569.05
1943													
Precipitation	26.2	37.1	8.2	24.5	51.6	70.1	94.8	84.1	110.1	37.4	24.9	22.8	591.8
Rain	0	0	0	15	48.3	70.1	94.8	84.1	110.1	27.9	0	0	450.3
Snow	26.2	37.1	8.2	9.5	3.3	0	0	0	0	9.5	24.9	22.8	141.5
Snow Melt and Rain	0	0	0	141.7	86.66	70.1	94.8	84.1	110.1	36.6	0	0	624.1
1944													
Precipitation	45.1	15.5	37.3	12.7	37.3	89.8	141.1	44.4	55.5	66.7	42.4	50	637.8
Rain	0	0	0	7.9	30.4	89.8	141.1	44.4	55.5	53.5	0	0	422.6
Snow	45.1	15.5	37.3	4.8	6.9	0	0	0	0	13.2	42.4	50	215.2
Snow Melt and Rain	0	0	0	159.1	37.3	89.8	141.1	44.4	55.5	66.2	0.9	0	594.3
1945													
Precipitation	9.4	25.7	60.9	66	32.8	92.4	50.1	44.4	-	-	-	-	381.7
Rain	0	0	13.9	43.9	23.4	92.4	50.1	44.4	-	-	-	-	268.1
Snow	9.4	25.7	47	22.1	9.4	0	0	0	-	-	-	-	113.6
Snow Melt and Rain	0	0	82.78	82.07	122	92.4	50.1	44.4	-	-	-	-	473.7
1946													
Precipitation	-	-	-	-	-	68.3	46.8	72.7	56.9	89.6	51.5	38.3	424.1
Rain	-	-	-	-	-	68.3	46.8	72.7	56.9	30.9	1.8	0	277.4
Snow	-	-	-	-	-	0	0	0	0	58.7	49.7	38.3	146.7
Snow Melt and Rain	-	-	-	-	-	68.3	46.8	72.7	56.9	63.5	29.31	0	337.51

1947													
Precipitation	48.1	58.9	19.9	25.7	57	40.1	131.4	135.7	82.2	26.7	43.8	28	697.5
Rain	0	0	0	2.6	48.1	40.1	131.4	135.7	82.2	26.7	30	0	496.8
Snow	48.1	58.9	19.9	23.1	8.9	0	0	0	0	0	13.8	28	200.7
Snow Melt and Rain	0	0	0	31.19	264.5	40.59	131.4	135.7	82.2	26.7	30	0	742.29
1948													
Precipitation	15.4	25.7	10.7	24.9	28.7	81.3	181.8	88.7	57.7	29.3	65.2	56.7	666.1
Rain	0	0	0	14.7	22.6	81.3	181.8	88.7	57.7	28.2	48	0	523
Snow	15.4	25.7	10.7	10.2	6.1	0	0	0	0	1.1	17.2	56.7	143.1
Snow Melt and Rain	0	0	10.8	107.7	28.7	81.3	181.8	88.7	57.7	29.3	48	0	634
1949													
Precipitation	44.7	22	13.5	21.4	55.9	58.9	67	115.8	59.9	58	41.4	68.9	627.4
Rain	0	0	0	6.6	54.9	58.9	67	115.8	59.9	45.3	2.1	0	410.5
Snow	44.7	22	13.5	14.8	1	0	0	0	0	12.7	39.3	68.9	216.9
Snow Melt and Rain	0	0	0	151.4	80.01	58.9	67	115.8	59.9	57	7.23	0	597.23
1950													
Precipitation	32.5	21.3	11.8	63.3	45.7	129.7	80.6	52.5	16.2	70.7	27.3	34.2	585.8
Rain	0	0	0	2.8	36.2	129.7	80.6	52.5	16.2	65.8	0	0	383.8
Snow	32.5	21.3	11.8	60.5	9.5	0	0	0	0	4.9	27.3	34.2	202
Snow Melt and Rain	0	0	0	19.64	259	129.7	80.6	52.5	16.2	70.7	0	0	628.37
1951													
Precipitation	16.9	14.8	29	38.1	37.9	57.9	123.9	69.8	61.3	73.1	16.9	30.8	570.4
Rain	0	0	0	4.8	34.8	57.9	123.9	69.8	61.3	26.3	0	2	380.8
Snow	16.9	14.8	29	33.3	3.1	0	0	0	0	46.8	16.9	28.8	189.6
Snow Melt and Rain	0	3.3	7.5	109.9	77.54	57.9	123.9	69.8	61.3	27.1	0	14.02	552.22
1952													
Precipitation	47.3	22.5	22.6	29.5	55.6	130.4	107.3	86.4	61	99.3	35.2	19.4	716.5
Rain	0	0	0	13.5	55.6	130.4	107.3	86.4	61	40.1	2	1.5	497.8
Snow	47.3	22.5	22.6	16	0	0	0	0	0	59.2	33.2	17.9	218.7
Snow Melt and Rain	0	0	0	201.6	55.6	130.4	107.3	86.4	61	76.4	21.23	4.22	744.13
1953													
Precipitation	25.5	29.2	24.6	16.5	40.5	74.1	87	19	32.6	34.8	34.5	35.4	453.7
Rain	0	0	7.1	0.3	27.5	74.1	87	19	32.6	18.8	0.5	0	266.9
Snow	25.5	29.2	17.5	16.2	13	0	0	0	0	16	34	35.4	186.8
Snow Melt and Rain	0	0	27.61	27	133.7	74.1	87	19	32.6	20.8	26.02	0	447.87
1954													

Precipitation	15.3	33.3	25.3	69.6	66.7	89.8	65.9	67	90	59.3	12	11.2	605.4
Rain	0	0.3	0	3.6	20.7	89.8	65.9	67	90	29.3	0	0	366.6
Snow	15.3	33	25.3	66	46	0	0	0	0	30	12	11.2	238.8
Snow Melt and Rain	0	15.32	0	47.24	205.5	89.8	65.9	67	90	29.8	0.9	0	611.48
1955													
Precipitation	16.8	22.8	49.4	9.4	80.4	84.7	70.2	86.7	111.1	57.6	55.6	12.7	657.4
Rain	0	0	0	7.1	80.4	84.7	70.2	86.7	111.1	40.1	1	0	481.3
Snow	16.8	22.8	49.4	2.3	0	0	0	0	0	17.5	54.6	12.7	176.1
Snow Melt and Rain	0	0	15.3	134.9	80.4	84.7	70.2	86.7	111.1	44.95	6.12	0	634.37
1956													
Precipitation	23.1	27.2	5.7	26.4	58.3	21.6	65.8	82.7	46	45.3	53.3	17.3	472.7
Rain	0	0	0	0	51.9	21.6	65.8	82.7	46	45.3	19.6	0	332.9
Snow	23.1	27.2	5.7	26.4	6.4	0	0	0	0	0	33.7	17.3	139.8
Snow Melt and Rain	0	0	0	9.3	206.2	21.6	65.8	82.7	46	45.3	19.6	0	496.53
1957													
Precipitation	10.2	30.2	41	21.4	19.9	107.7	72.5	66.9	40.7	26.5	75.5	52.5	565
Rain	0	0	0	15.3	14.1	107.7	72.5	66.9	40.7	21.9	0.8	0	339.9
Snow	10.2	30.2	41	6.1	5.8	0	0	0	0	4.6	74.7	52.5	225.1
Snow Melt and Rain	0	0	0	153.8	19.9	107.7	72.5	66.9	40.7	26.5	6.2	0	494.2
1958													
Precipitation	38	46.5	31.5	99.5	45.1	48.7	63.7	91.1	145.2	56.4	42.2	40.4	748.3
Rain	0	0	0	10.2	29.7	48.7	63.7	91.1	145.2	36.3	0.8	0	425.7
Snow	38	46.5	31.5	89.3	15.4	0	0	0	0	20.1	41.4	40.4	322.6
Snow Melt and Rain	0	0	0	153.6	228.8	48.7	63.7	91.1	145.2	56.4	5.91	0	793.41
1959													
Precipitation	17.1	16.3	31	45	143.7	123.9	112.2	127	115.7	125.8	59.3	22.6	939.6
Rain	0	0	0.3	5.1	139.1	123.9	112.2	127	115.7	37.9	0	0	661.2
Snow	17.1	16.3	30.7	39.9	4.6	0	0	0	0	87.9	59.3	22.6	278.4
Snow Melt and Rain	0	0	17.7	43.65	268.4	123.9	112.2	127	115.7	49.95	0	0	858.54
1960													
Precipitation	35.2	15.4	13.3	52.4	51	59.7	52	31.2	52.2	64.8	65.3	41.9	534.4
Rain	0	0	0	17.5	49.7	59.7	52	31.2	52.2	46.7	22.1	0	331.1
Snow	35.2	15.4	13.3	34.9	1.3	0	0	0	0	18.1	43.2	41.9	203.3
Snow Melt and Rain	0	0	0	66.2	258.9	59.7	52	31.2	52.2	64.8	22.1	0	607.05
1961													
Precipitation	19.4	44.5	84.4	50.7	28.3	28.8	44.4	45.9	63.9	61	30.8	56.1	558.2

Rain	0	0	0	9	28	28.8	44.4	45.9	63.9	13.4	0	0	233.4
Snow	19.4	44.5	84.4	41.7	0.3	0	0	0	0	47.6	30.8	56.1	324.8
Snow Melt and Rain	0	0	6	77.1	229.3	28.8	44.4	45.9	63.9	19.8	2.7	0	517.9
1962													
Precipitation	15.4	16.6	10.8	41.2	53.7	16.4	55.9	92.2	61.6	31.7	66.8	57	519.3
Rain	0	0	0.8	0.8	53.4	16.4	55.9	92.2	61.6	24.5	3.6	1.8	311
Snow	15.4	16.6	10	40.4	0.3	0	0	0	0	7.2	63.2	55.2	208.3
Snow Melt and Rain	0	0	6.52	18.52	238.1	16.4	55.9	92.2	61.6	30.6	25.3	16.24	561.33
1963													
Precipitation	29.7	31.5	20.9	95.8	46.3	128.6	91.2	54.7	34	34.6	61	18.8	647.1
Rain	0	0	0	24.7	46.3	128.6	91.2	54.7	34	34.6	21	0	435.1
Snow	29.7	31.5	20.9	71.1	0	0	0	0	0	0	40	18.8	212
Snow Melt and Rain	0	0	6	135.6	165.9	128.6	91.2	54.7	34	34.6	27.6	0	678.27
1964													
Precipitation	65.4	20.1	23.7	31.4	60.7	67.5	63.2	98.5	107.6	37.9	19.4	32.3	627.7
Rain	0	0	0	1.3	60.7	67.5	63.2	98.5	101.7	18.8	0.6	0	412.3
Snow	65.4	20.1	23.7	30.1	0	0	0	0	5.9	19.1	18.8	32.3	215.4
Snow Melt and Rain	0	0	0	191.6	61.94	67.5	63.2	98.5	107.6	37.9	0.6	0	628.8
1965													
Precipitation	31.9	29.8	21.1	25.2	84.5	56	89.8	51.8	55.9	88.1	40.9	23.9	598.9
Rain	0	0	0	3.8	80.4	56	89.8	51.8	54.1	80.2	0	0	416.1
Snow	31.9	29.8	21.1	21.4	4.1	0	0	0	1.8	7.9	40.9	23.9	182.8
Snow Melt and Rain	0	0	0	125.5	118.1	56	89.8	51.8	55.9	86.6	0	0	583.7
1966													
Precipitation	58	22.6	43.2	33.9	52.9	171.3	63.5	42.5	72.2	70.6	15.7	25.6	672
Rain	0	0.3	0	11.2	48.3	171.3	63.5	42.5	72.2	26.1	1.8	0	437.2
Snow	58	22.3	43.2	22.7	4.6	0	0	0	0	44.5	13.9	25.6	234.8
Snow Melt and Rain	0	3	5.1	46.78	222	171.3	63.5	42.5	72.2	40.2	5.41	0	672.01
1967													
Precipitation	27.7	13.9	24	39.6	56.5	24.6	120.9	39.9	55.1	61.9	30.9	57.2	552.2
Rain	0	0	3.1	0.8	26.5	24.6	120.9	39.9	55.1	34.4	1.8	0	307.1
Snow	27.7	13.9	20.9	38.8	30	0	0	0	0	27.5	29.1	57.2	245.1
Snow Melt and Rain	0	0	23.62	10.11	194.3	24.6	120.9	39.9	55.1	48.34	6.94	0	523.77
1968													
Precipitation	20.1	14.5	26.7	73.1	39.1	83.3	118.7	88.9	15	180.4	48.7	15.4	723.9
Rain	0	0	10.6	28.3	38.6	83.3	118.7	88.9	15	177.9	14.7	0	576

Snow	20.1	14.5	16.1	44.8	0.5	0	0	0	0	2.5	34	15.4	147.9
Snow Melt and Rain	0	0	53.37	159.1	55.78	83.3	118.7	88.9	15	180.4	14.7	0	769.22
1969													
Precipitation	94.5	6	9	5.9	64.6	222.4	47	104	164.4	35.5	84.3	14.7	852.3
Rain	0	0	0	3.6	50.1	222.4	47	104	164.4	18.5	7.9	0	617.9
Snow	94.5	6	9	2.3	14.5	0	0	0	0	17	76.4	14.7	234.4
Snow Melt and Rain	0	0	0	164.8	64.6	222.4	47	104	164.4	35.5	8.2	0	810.9
1970													
Precipitation	23.3	13.8	21.8	27.2	62.4	52.6	119.4	138.2	123.6	89.6	31.5	50.7	754.1
Rain	0	0	0	17.5	61.4	52.6	119.4	138.2	123.6	84.7	7.1	0	604.5
Snow	23.3	13.8	21.8	9.7	1	0	0	0	0	4.9	24.4	50.7	149.6
Snow Melt and Rain	0	0	9.3	122.9	107.2	52.6	119.4	138.2	123.6	89.6	7.1	0	769.8
1971													
Precipitation	23.7	58.5	16.6	95.4	36.8	49.7	186.6	41.2	130.8	98.6	40.9	58.9	837.7
Rain	0	0	0	19.1	36.8	49.7	186.6	41.2	130.8	80.3	0.3	0	544.8
Snow	23.7	58.5	16.6	76.3	0	0	0	0	0	18.3	40.6	58.9	292.9
Snow Melt and Rain	0	0	0	142.9	163.2	49.7	186.6	41.2	130.8	86.94	2.1	0	803.44
1972													
Precipitation	42.1	14.2	24.7	7.6	68	61	155.1	64	120.1	76.9	49	34.6	717.3
Rain	0	0	0.3	2.6	53.5	61	155.1	64	115.3	45.2	0	0	497
Snow	42.1	14.2	24.4	5	14.5	0	0	0	4.8	31.7	49	34.6	220.3
Snow Melt and Rain	0	0	12.31	135.3	118.4	61	155.1	64	120.1	58.1	0	0	724.26
1973													
Precipitation	22.9	18.4	34.3	60.1	33.5	88.1	72	156.7	46.9	58.4	79.9	24	695.2
Rain	0	0	1	11	29	88.1	72	156.7	46.9	57.1	3	0	464.8
Snow	22.9	18.4	33.3	49.1	4.5	0	0	0	0	1.3	76.9	24	230.4
Snow Melt and Rain	0	0	28.33	69.64	173.6	88.1	72	156.7	46.9	58.4	7.25	0	700.95
1974													
Precipitation	32.9	13.1	44.3	53.7	65.2	89.7	186.8	208.7	58.1	39.4	61.5	31.1	884.5
Rain	0	0	0	9.7	62.6	89.7	186.8	208.7	58.1	32.3	0	0	647.9
Snow	32.9	13.1	44.3	44	2.6	0	0	0	0	7.1	61.5	31.1	236.6
Snow Melt and Rain	0	0	0	103.3	202.6	89.7	186.8	208.7	58.1	39.4	7.9	0	896.45
1975													
Precipitation	39.5	9.7	18.7	21.2	51.7	99.6	229.1	146.9	50.7	59.9	35.2	24	786.2
Rain	0	0	0	6.2	45.6	99.6	229.1	146.9	50.7	45.7	6.9	0	630.7
Snow	39.5	9.7	18.7	15	6.1	0	0	0	0	14.2	28.3	24	155.5

Snow Melt and Rain		0	0	14.1	133	78.37	99.6	229.1	146.9	50.7	59.9	18.9	0	830.6
	1976													
Precipitation		26.8	30	50.7	46	27.8	98.8	71.5	117.1	123.9	14.9	43.3	37	687.8
Rain		0	0.3	5.6	9.1	7.2	98.8	71.5	117.1	123.9	6.1	10.7	0	450.3
Snow		26.8	29.7	45.1	36.9	20.6	0	0	0	0	8.8	32.6	37	237.5
Snow Melt and Rain		0	2.1	18.26	155.7	45.55	98.8	71.5	117.1	123.9	14.9	10.7	0	658.5
	1977													
Precipitation		30.4	51.6	14.2	14.5	61.1	67	106.9	105.7	84.2	30.6	85.6	26	677.8
Rain		0	0	2.9	13.2	34.8	67	106.9	105.7	84.2	30.2	12.1	0	457
Snow		30.4	51.6	11.3	1.3	26.3	0	0	0	0	0.4	73.5	26	220.8
Snow Melt and Rain		0	0	16.72	163.6	61.1	67	106.9	105.7	84.2	30.6	12.1	0	647.9
	1978													
Precipitation		8.5	21.1	41.2	28.6	71.6	60.8	71.6	160.6	88.6	38	41.8	21	653.4
Rain		0	0	0	0	71.6	60.8	71.6	160.6	88.6	29.6	16.6	0	499.4
Snow		8.5	21.1	41.2	28.6	0	0	0	0	0	8.4	25.2	21	154
Snow Melt and Rain		0	0	0	74.7	195.8	60.8	71.6	160.6	88.6	38	18.2	0	708.3
	1979													
Precipitation		12.4	22	42.7	44.2	79.7	84.8	103.4	85.5	113.4	93.9	73.9	26.6	782.5
Rain		0	0	18.7	42.4	73.6	84.8	103.4	85.5	113.4	68.3	4.8	0	594.9
Snow		12.4	22	24	1.8	6.1	0	0	0	0	25.6	69.1	26.6	187.6
Snow Melt and Rain		0	0	49.49	116.4	79.7	84.8	103.4	85.5	113.4	90.89	7.81	0	731.4
	1980													
Precipitation		40	7.3	22.7	11.5	14.8	87.9	60	59.6	102.1	94.9	15.1	18.2	534.1
Rain		0	0	0	3.4	14.8	87.9	60	59.6	102.1	50.4	2.6	0	380.8
Snow		40	7.3	22.7	8.1	0	0	0	0	0	44.5	12.5	18.2	153.3
Snow Melt and Rain		0	0	14.1	163.1	14.8	87.9	60	59.6	102.1	60.74	6.85	0	569.18
	1981													
Precipitation		9	40.9	22.6	40.5	28.6	49.3	38.7	38.8	61.9	40.6	59.4	24.8	455.1
Rain		0	8.4	7.8	1	24.4	49.3	38.7	38.8	61.9	24.4	27	0	281.7
Snow		9	32.5	14.8	39.5	4.2	0	0	0	0	16.2	32.4	24.8	173.4
Snow Melt and Rain		0	29.48	24.77	50.55	97.03	49.3	38.7	38.8	61.9	40.6	33.2	0	464.32
	1982													
Precipitation		32.2	18.3	57.4	54.2	91.2	101.2	77	90.4	136.4	75.2	37.6	39.8	810.9
Rain		0	0	7	7.8	91.2	101.2	77	90.4	136.4	65.8	22.2	4.6	603.6
Snow		32.2	18.3	50.4	46.4	0	0	0	0	0	9.4	15.4	35.2	207.3
Snow Melt and Rain		0	0	19.97	128.6	155.7	101.2	77	90.4	136.4	75.2	29.4	12.8	826.7

1983													
Precipitation	40.6	7	41.9	15.6	31.2	77.8	98.1	61.3	64.4	49.4	100.9	16.6	604.8
Rain	0	0	0	6.8	22	77.8	98.1	61.3	64.4	49	12.6	0	392
Snow	40.6	7	41.9	8.8	9.2	0	0	0	0	0.4	88.3	16.6	212.8
Snow Melt and Rain	0	0	0	86.06	85.44	77.8	98.1	61.3	64.4	49.4	18.8	0	541.3
1984													
Precipitation	26	18.6	17	50.6	34.8	97	114	63.1	69.9	48.7	65.5	63.7	668.9
Rain	0	1.4	0	48.2	32.2	97	114	63.1	69.9	36.1	0	0	461.9
Snow	26	17.2	17	2.4	2.6	0	0	0	0	12.6	65.5	63.7	207
Snow Melt and Rain	0	1.7	0	206.8	37.2	97	114	63.1	69.9	41.3	1.5	0	632.5
1985													
Precipitation	16.3	10.2	33.6	94	74.8	151.8	79.2	105.9	141.8	47.4	57.4	26.4	838.8
Rain	0	0	2.4	68.4	74.8	151.8	79.2	105.9	141.8	25.6	21.8	0	671.7
Snow	16.3	10.2	31.2	25.6	0	0	0	0	0	21.8	35.6	26.4	167.1
Snow Melt and Rain	0	0	19.3	261.4	83.28	151.8	79.2	105.9	141.8	47.4	21.8	0	911.9
1986													
Precipitation	22.6	22.8	28.4	102.9	40	46.2	90.2	52.8	92	48.6	52.6	35.2	634.3
Rain	0	0	8	72.2	39.8	46.2	90.2	52.8	92	27.3	0	0	428.5
Snow	22.6	22.8	20.4	30.7	0.2	0	0	0	0	21.3	52.6	35.2	205.8
Snow Melt and Rain	0	0	40.28	185.3	53.09	46.2	90.2	52.8	92	35.8	0	0	595.7
1987													
Precipitation	15	15	28.8	31.4	41	95.2	115	192.3	37.9	50.1	22.4	26.7	670.8
Rain	0	0	7	31.4	41	95.2	115	192.3	37.9	36.4	10.5	0.8	567.5
Snow	15	15	21.8	0	0	0	0	0	0	13.7	11.9	25.9	103.3
Snow Melt and Rain	0	0	50.19	140.6	41	95.2	115	192.3	37.9	39	25.04	3.5	739.74
1988													
Precipitation	28.4	20.7	46	17.4	51.6	52.4	79.2	97.2	144	52.4	64.6	42.4	696.3
Rain	0	0	0	3.8	51.4	52.4	79.2	97.2	144	41.6	0	0	469.6
Snow	28.4	20.7	46	13.6	0.2	0	0	0	0	10.8	64.6	42.4	226.7
Snow Melt and Rain	0	0	0	144.2	51.6	52.4	79.2	97.2	144	42.6	13.5	0	624.66
1989													
Precipitation	35.4	14.2	14.2	6.2	60.2	77.2	-	-	-	-	-	-	207.4
Rain	0	0	0	0	59	77.2	-	-	-	-	-	-	136.2
Snow	35.4	14.2	14.2	6.2	1.2	0	-	-	-	-	-	-	71.2
Snow Melt and Rain	0	0	0.9	64.2	168.4	77.2	-	-	-	-	-	-	310.7

Table 6. **Monthly and annual precipitation and snowmelt at the Fort Albany meteorological station in the Albany River drainage basin.**

(All values in mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1984													
Precipitation	19.5	18.6	14	0	72.2	153	263	134.2	54.7	49	12	45	835.3
Rain	0	0	0	0	35.2	131	263	134.2	45.7	37.6	1	0	647.8
Snow	19.5	18.6	14	0	37	22	0	0	9	11.4	11	45	187.5
Snow Melt and Rain	0	9.9	0	42.2	36.2	131	263	134.2	54.7	49	8.83	0	729.13
1985													
Precipitation	10	29.9	2	0	25.9	66	174	86.8	81	57	13	16	561.1
Rain	0	0	2	0	22.9	60	174	86.8	81	40	0	0	466.2
Snow	10	29.9	0	0	3	6	0	0	0	17	13	16	94.9
Snow Melt and Rain	0	0	67.1	0	25.9	60	174	86.8	81	57	0	0	551.27
1986													
Precipitation	3	14	27	3	0	56.4	43	34	-	95.5	22.2	10	308.1
Rain	0	0	0	1	0	56.4	38	34	-	63.5	0	0	192.9
Snow	3	14	27	2	0	0	5	0	-	32	22.2	10	115.2
Snow Melt and Rain	0	0	0	72	0	56.4	38	34	-	86.43	0	0	286.82
1987													
Precipitation	16.6	17	17	29.8	35.4	69.6	60.8	137	54.4	39	30	23	529.6
Rain	0	0	0	18	35.4	69.6	60.8	137	54.4	18	1	0	394.2
Snow	16.6	17	17	11.8	0	0	0	0	0	21	29	23	135.4
Snow Melt and Rain	0	0	21.3	93.6	42.2	69.6	60.8	137	54.4	39	4	0	521.87
1988													
Precipitation	0	18	22.4	26.4	32.6	1.3	44.4	17.4	66.2	46.2	53.8	34	362.7
Rain	0	0	1.2	18.8	21.2	1.3	44.4	17.4	66.2	30.8	33	0	234.3
Snow	0	18	21.2	7.6	11.4	0	0	0	0	15.4	20.8	34	128.4
Snow Melt and Rain	0	0	3.61	97.2	44.6	1.3	44.4	17.4	66.2	30.8	53.2	0	358.7
1989													
Precipitation	-	-	-	18	-	0	8	19.8	1	7	-	-	53.8
Rain	-	-	-	2	-	0	0	19.8	1	7	-	-	29.8
Snow	-	-	-	16	-	0	8	0	0	0	-	-	24
Snow Melt and Rain	-	-	-	5.31	-	43.7	0	19.8	1	7	-	-	76.8

Table 7. Monthly and annual precipitation and snowmelt at the Moosonee meteorological station in the Moose River drainage basin.

(All values in mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1982													
Precipitation	42.4	12	32	74.1	32.6	75.3	116.1	87.4	102.3	57	56.2	38	725.4
Rain	0	0	9.3	15.1	32.6	75.3	116.1	87.4	102.3	57	31.6	0.2	526.9
Snow	42.4	12	22.7	59	0	0	0	0	0	0	24.6	37.8	198.5
Snow Melt and Rain	0	0	21.96	128.2	73	75.3	116.1	87.4	102.3	57	51.6	4.8	717.7
1983													
Precipitation	27.5	24.5	28.1	36.2	50.4	35.6	68	51.6	75.3	141.5	90.1	19.2	648
Rain	0	0	2.3	11.9	40.3	35.6	68	51.6	75.3	140.5	38.9	0	464.4
Snow	27.5	24.5	25.8	24.3	10.1	0	0	0	0	1	51.2	19.2	183.6
Snow Melt and Rain	0	0	4.12	73.99	126.4	35.6	68	51.6	75.3	141.5	55.1	0	631.6
1984													
Precipitation	18.8	38.2	62.2	17.4	71.6	175.4	131.2	43.6	80.3	51.8	43.6	105	839.1
Rain	0	0.4	4.6	17.4	57.4	175.4	131.2	43.6	80.3	49	14.4	0	573.7
Snow	18.8	37.8	57.6	0	14.2	0	0	0	0	2.8	29.2	105	265.4
Snow Melt and Rain	0	13.92	8.88	168	71.6	175.4	131.2	43.6	80.3	49.2	46.2	0	788.3
1985													
Precipitation	26.3	55.2	16.5	47.6	48	90.5	138.3	84.9	110.6	76.3	76.2	19.5	789.9
Rain	0	0	0	7.2	46.8	90.5	138.3	84.9	110.6	73.5	30.6	0	582.4
Snow	26.3	55.2	16.5	40.4	1.2	0	0	0	0	2.8	45.6	19.5	207.5
Snow Melt and Rain	0	0	2.7	215.7	80.24	90.5	138.3	84.9	110.6	76.3	30.6	0	829.8
1986													
Precipitation	37.4	23.1	50.3	60.4	15.5	93.6	189.3	103.8	94.1	80.1	43.8	25.6	817
Rain	0	0	9.6	49.6	13.4	93.6	189.3	103.8	94.1	75.1	10.6	1.2	640.3
Snow	37.4	23.1	40.7	10.8	2.1	0	0	0	0	5	33.2	24.4	176.7
Snow Melt and Rain	0	0	23.26	213	15.5	93.6	189.3	103.8	94.1	80.1	12.4	2.4	827.5
1987													
Precipitation	20.6	12.3	21.4	37.3	59.3	52.9	102	158.2	36.4	50.6	60.1	48.6	659.7
Rain	0	0	0	36.8	58.7	52.9	102	158.2	36.4	44.2	42.8	6.9	538.9
Snow	20.6	12.3	21.4	0.5	0.6	0	0	0	0	6.4	17.3	41.7	120.8
Snow Melt and Rain	0	0	43.8	102.2	59.5	52.9	102	158.2	36.4	49	47.6	9.02	660.62

	1988												
Precipitation	32.3	34.3	41.2	64.5	79.7	43.3	116	75.3	107	78.1	82.4	38.1	792.2
Rain	0	0	3.4	35.5	79.1	43.3	116	75.3	107	40.3	63.4	0	563.3
Snow	32.3	34.3	37.8	29	0.6	0	0	0	0	37.8	19	38.1	228.9
Snow Melt and Rain	0	0	5.51	144.2	156	43.3	116	75.3	107	47.3	98.7	0	793.28
	1989												
Precipitation	48.6	12	15	9.5	25.2	39.4	92.1	56.6	90.5	73.6	86.7	19.6	568.8
Rain	0	0	1	6.4	25.2	39.4	92.1	56.6	90.5	56.4	10	0	377.6
Snow	48.6	12	14	3.1	0	0	0	0	0	17.2	76.7	19.6	191.2
Snow Melt and Rain	0	0	9.74	39.19	114	39.4	92.1	56.6	90.5	73.6	22	0	537.1
	1990												
Precipitation	53.4	28	19.2	36.2	52.2	163.4	66.5	87.8	94.8	61.2	49.4	43.8	755.9
Rain	0	0.4	3	19.2	27.2	163.4	66.5	87.8	94.8	60.8	23.6	0	546.7
Snow	53.4	27.6	16.2	17	25	0	0	0	0	0.4	25.8	43.8	209.2
Snow Melt and Rain	0	6.41	67.1	147.6	52.2	163.4	66.5	87.8	94.8	61.2	29.8	0	776.8
	1991												
Precipitation	26	5.4	57	23.3	87.6	25.9	64.7	88.6	144	71.6	104.6	26.6	725.3
Rain	0	0	0	22.4	85.4	25.9	64.7	88.6	144	68.2	7	0	506.2
Snow	26	5.4	57	0.9	2.2	0	0	0	0	3.4	97.6	26.6	219.1
Snow Melt and Rain	0	5.7	6.3	163.1	87.6	25.9	64.7	88.6	144	71.6	23.8	0	681.3
	1992												
Precipitation	16.8	18.2	24	51.2	46.3	33.3	127.6	109	109.6	67.4	72.2	44.6	720.2
Rain	4	0	0	35.8	43.5	33.3	127.6	109	109.6	52.4	17.6	7.8	540.6
Snow	12.8	18.2	24	15.4	2.8	0	0	0	0	15	54.6	36.8	179.6
Snow Melt and Rain	12.17	0	0	98.27	153.5	33.3	127.6	109	109.6	66	19.4	11.5	740.32
	1993												
Precipitation	17.8	14.8	15.2	32.8	2.2	55.8	126.1	79.2	158.2	63.2	15.2	3.8	584.3
Rain	0	0	0	14.8	2.2	55.8	126.1	79.2	158.2	50.6	3.4	0	490.3
Snow	17.8	14.8	15.2	18	0	0	0	0	0	12.6	11.8	3.8	94
Snow Melt and Rain	0	0	54.3	99.64	16.15	55.8	126.1	79.2	158.2	63.2	7.63	0	660.21

Table 8. Monthly and annual precipitation and snowmelt at the New Liskeard meteorological station in the Montreal River drainage basin.

(All values in mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1966													
Precipitation	48.2	10.1	75.8	15.2	22.3	74.7	140.8	112.1	81.3	76.6	165.7	-	822.8
Rain	0	2.5	37	15.2	18.5	69.6	140.8	112.1	68.1	75.3	80.3	-	619.4
Snow	48.2	7.6	38.8	0	3.8	5.1	0	0	13.2	1.3	85.4	-	203.4
Snow Melt and Rain	0	20.51	78.27	99.65	22.3	69.6	140.8	112.1	68.1	76.6	123.5	-	811.43
1967													
Precipitation	97.8	49.5	28.4	121.7	52.9	109.4	67.4	83.4	54.1	67.9	82.7	23	838.2
Rain	0	0	0	121.7	52.9	109.4	60.8	77.6	49.3	67.9	46.9	0	586.5
Snow	97.8	49.5	28.4	0	0	0	6.6	5.8	4.8	0	35.8	23	251.7
Snow Melt and Rain	0	0	43.5	279.6	52.9	109.4	60.8	77.6	49.3	67.9	53	8.4	802.4
1968													
Precipitation	11	50.6	24.5	45.2	44.3	131.5	110.1	47.3	134.2	49.3	62.5	73.6	784.1
Rain	0	0	3.8	45.2	44.3	118	71.5	42.5	117.7	43.7	1.5	15.2	503.4
Snow	11	50.6	20.7	0	0	13.5	38.6	4.8	16.5	5.6	61	58.4	280.7
Snow Melt and Rain	0.9	0	99.4	45.2	44.3	118	71.5	42.5	117.7	43.7	1.5	18.71	603.41
1969													
Precipitation	75.5	20.2	39.5	25.2	52.2	119.5	107.4	42.6	84.5	144	93.4	43.2	847.6
Rain	3	0	0	11.2	52.2	94.9	84	42.6	75.4	106	64	0	533.6
Snow	72.5	20.2	39.5	14	0	24.6	23.4	0	9.1	38.1	29.4	43.2	314
Snow Melt and Rain	24.69	0	2.4	225.6	52.2	94.9	84	42.6	75.4	107	69.1	1.8	779.99
1970													
Precipitation	26.3	27.3	24.8	39.2	113.6	109.3	103	33.8	78.3	42.2	34.5	46.6	678.9
Rain	0	0	0	35.4	16.5	109.3	77.8	16.3	68.6	42.2	13.8	0	379.9
Snow	26.3	27.3	24.8	3.8	97.1	0	25.2	17.5	9.7	0	20.7	46.6	299
Snow Melt and Rain	0	0	4.2	153.7	16.5	109.3	77.8	16.3	68.6	42.2	15.1	8.5	512.2
1971													
Precipitation	78.9	54.4	27.6	26.6	48.7	50.1	-	64.5	46.5	46.2	66.7	60.2	570.4
Rain	0	8.9	0	16.5	48.7	50.1	-	55.6	29.7	46.2	55.1	20.3	331.1
Snow	78.9	45.5	27.6	10.1	0	0	-	8.9	16.8	0	11.6	39.9	239.3
Snow Melt and Rain	0	19.34	6	192.1	48.7	50.1	-	55.6	29.7	46.2	60.1	31	538.8

	1972												
Precipitation	46	28.8	63.7	20.6	28.2	71.9	89	141.5	67.3	34.7	30.9	50.7	673.3
Rain	0	0	1	8.1	28.2	71.9	89	141.5	67.3	26.8	28.9	0	462.7
Snow	46	28.8	62.7	12.5	0	0	0	0	0	7.9	2	50.7	210.6
Snow Melt and Rain	0	0	6.12	169.8	31.63	71.9	89	141.5	67.3	33.2	30.9	0	641.3
	1973												
Precipitation	16.8	21.9	41.6	40	86.1	144.5	66.2	88.6	48.7	80	38.8	36.7	709.9
Rain	1.3	0	26.9	33.2	86.1	144.5	66.2	88.6	48.7	80	22.6	2.5	600.6
Snow	15.5	21.9	14.7	6.8	0	0	0	0	0	0	16.2	34.2	109.3
Snow Melt and Rain	25.31	0	105.7	37.2	86.1	144.5	66.2	88.6	48.7	80	28.4	9.13	719.83
	1974												
Precipitation	59.3	44.1	-	51.1	71	61.3	56	81.4	149.2	61.5	30.5	51.5	716.9
Rain	2.5	0	-	40.9	71	61.3	56	81.4	149.2	61.5	5.8	0	529.6
Snow	56.8	44.1	-	10.2	0	0	0	0	0	0	24.7	51.5	187.3
Snow Melt and Rain	4.32	0	-	184.1	71	61.3	56	81.4	149.2	61.5	5.8	2.7	677.27
	1975												
Precipitation	52.2	12.7	50.8	48.8	89	51.6	76.7	49.8	53	54.9	50.2	30.1	619.8
Rain	0	1.3	4.1	43.7	89	51.6	76.7	49.8	53	54.9	22.8	0	446.9
Snow	52.2	11.4	46.7	5.1	0	0	0	0	0	0	27.4	30.1	172.9
Snow Melt and Rain	12.6	9.11	26.46	189.8	89	51.6	76.7	49.8	53	54.9	41.1	4.2	658.3
	1976												
Precipitation	58.4	68.1	72.9	29	93.4	47.1	51.4	31.4	127.5	57.4	25.6	-	662.2
Rain	0	0	18.6	29	93.4	47.1	51.4	31.4	127.5	56.1	0	-	454.5
Snow	58.4	68.1	54.3	0	0	0	0	0	0	1.3	25.6	-	207.7
Snow Melt and Rain	0	6	103.5	148.8	93.4	47.1	51.4	31.4	127.5	57.4	2.8	-	669.3
	1977												
Precipitation	32.7	36.8	61.7	43.5	10.4	72.8	41.2	71.4	62.2	52.1	19.5	28.6	532.9
Rain	0	0	0.8	14	10.4	72.8	41.2	71.4	57.9	52.1	13.5	7.6	341.7
Snow	32.7	36.8	60.9	29.5	0	0	0	0	4.3	0	6	21	191.2
Snow Melt and Rain	0	2.7	80.35	93.35	10.4	72.8	41.2	71.4	57.9	52.1	15	10.65	507.85
	1978												
Precipitation	55	3	28	37.5	21.2	99.7	75.3	67.4	72.1	67.8	37	50	614
Rain	0	0	0	6.3	21.2	96.5	75.3	67.4	72.1	40.4	0	0	379.2
Snow	55	3	28	31.2	0	3.2	0	0	0	27.4	37	50	234.8
Snow Melt and Rain	0	0	0	79.91	87.25	96.5	75.3	67.4	72.1	42.4	3	0	523.85

	1979												
Precipitation	36	5	62	75.6	100.1	117.6	117.2	55.4	68.8	122	63.8	13.5	837
Rain	0	0	18	34.3	100.1	117.6	117.2	55.4	68.8	120	34.6	0.5	666.5
Snow	36	5	44	41.3	0	0	0	0	0	2	29.2	13	170.5
Snow Melt and Rain	0	0	60.79	111.2	110.4	117.6	117.2	55.4	68.8	122	62.8	1.4	827.6
	1980												
Precipitation	10	7.7	83.1	37.1	-	6	77.6	-	87.2	-	52	-	360.7
Rain	5	0	0	25	-	4	53	-	87.2	-	10	-	184.2
Snow	5	7.7	83.1	12.1	-	2	24.6	-	0	-	42	-	176.5
Snow Melt and Rain	15.63	0	16.5	95.67	-	4	53	-	87.2	-	11.5	-	283.5
	1981												
Precipitation	-	56	71	54	65.8	102.9	71.6	60.1	83.5	91	28.5	37.7	722.1
Rain	-	6	31	51	55	98.9	50.6	19.5	65	79	5	2	463
Snow	-	50	40	3	10.8	4	21	40.6	18.5	12	23.5	35.7	259.1
Snow Melt and Rain	-	80.5	45	54	55	98.9	50.6	19.5	65	79	5	8.04	560.54
	1982												
Precipitation	55	27	26.5	11	41	81.5	27.2	78	67.5	75	34.5	11.2	535.4
Rain	0	0	3.5	0	40	81.5	24	78	67.5	65	22	4.7	386.2
Snow	55	27	23	11	1	0	3.2	0	0	10	12.5	6.5	149.2
Snow Melt and Rain	0	0	42.4	52.06	40	81.5	24	78	67.5	65	22	6.2	478.66
	1983												
Precipitation	22	4	7.4	0	61	13.8	77.5	63.7	59	84.2	46	8	446.6
Rain	0	0	3	0	54	13.8	77.5	27.7	38	45.6	17	0	276.6
Snow	22	4	4.4	0	7	0	0	36	21	38.6	29	8	170
Snow Melt and Rain	0	0	12.35	12.15	54	13.8	77.5	27.7	38	47.6	30	0	313.1
	1984												
Precipitation	68	36	22	36	100	-	-	-	-	-	-	-	262
Rain	0	10	9	30	91	-	-	-	-	-	-	-	140
Snow	68	26	13	6	9	-	-	-	-	-	-	-	122
Snow Melt and Rain	0	56.36	23.64	30	91	-	-	-	-	-	-	-	201

Table 9. **Monthly and annual precipitation and snowmelt at the Lake Traverse meteorological station in the Petawawa River drainage basin.**

(All values in mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1965													
Precipitation	-	-	-	-	-	-	115.4	129.8	132.4	93.4	77.2	58.5	606.7
Rain	-	-	-	-	-	-	115.4	129.8	132.4	93.4	7.4	5.5	483.9
Snow	-	-	-	-	-	-	0	0	0	0	69.8	53	122.8
Snow Melt and Rain	-	-	-	-	-	-	115.4	129.8	132.4	93.4	15.42	39.81	526.24
1966													
Precipitation	66.1	25.4	45.5	26.2	42.5	77.9	54.5	108.2	62.3	51.9	158.3	61.8	780.6
Rain	0	0	23.3	23.1	42.5	77.9	54.5	108.2	62.3	43.3	142.1	3.1	580.3
Snow	66.1	25.4	22.2	3.1	0	0	0	0	0	8.6	16.2	58.7	200.3
Snow Melt and Rain	0	7.5	78.45	157.7	42.5	77.9	54.5	108.2	62.3	43.3	166.9	16.44	815.7
1967													
Precipitation	57.5	58.1	5.9	63.6	49	150.9	69.9	142	104.5	100.3	49.1	39.7	890.5
Rain	2.5	0	0	63.6	49	150.9	69.9	142	104.5	99.3	31	4.8	717.5
Snow	55	58.1	5.9	0	0	0	0	0	0	1	18.1	34.9	173
Snow Melt and Rain	23.82	0	70.5	136.1	49	150.9	69.9	142	104.5	100.3	39.4	22.57	909.03
1968													
Precipitation	24.9	65.5	36.1	50.8	28.4	96.9	97.5	42.7	71.8	46.1	45	73.3	679
Rain	0	13.7	19.6	50	28.4	96.9	97.5	42.7	71.8	45.6	19.3	0.5	486
Snow	24.9	51.8	16.5	0.8	0	0	0	0	0	0.5	25.7	72.8	193
Snow Melt and Rain	1.8	23.53	128	50.8	28.4	96.9	97.5	42.7	71.8	46.1	27.7	11.32	626.55
1969													
Precipitation	21.8	13.8	46	56.2	108.4	73.3	35.1	49.1	70.7	78.8	57	30.7	640.9
Rain	3.8	0	33	49.3	108.4	73.3	35.1	49.1	70.7	78.3	36	0	537
Snow	18	13.8	13	6.9	0	0	0	0	0	0.5	21	30.7	103.9
Snow Melt and Rain	13.78	2.7	76.63	124	108.4	73.3	35.1	49.1	70.7	78.8	42.4	1.8	676.68
1970													
Precipitation	12.5	33.9	59.1	51.9	70.8	62.3	192.4	38.5	83.1	46.9	42.9	59.7	754
Rain	0	0	4.1	21.4	70.8	62.3	192.4	38.5	83.1	46.9	29.2	5.8	554.5
Snow	12.5	33.9	55	30.5	0	0	0	0	0	0	13.7	53.9	199.5
Snow Melt and Rain	0	2.7	16.2	179.5	70.8	62.3	192.4	38.5	83.1	46.9	39.13	9.57	741.1

1971													
Precipitation	55.7	135	66.6	30.6	39.2	56.3	30.8	66.6	60.9	37.5	86.5	66.8	732.5
Rain	0	8.9	7.6	29.6	39.2	56.3	30.8	66.6	60.9	37.5	18.8	2.5	358.7
Snow	55.7	126.1	59	1	0	0	0	0	0	0	67.7	64.3	373.8
Snow Melt and Rain	0	24.46	25.86	291.5	39.2	56.3	30.8	66.6	60.9	37.5	50.4	40.15	723.65
1972													
Precipitation	40.8	72.7	61.4	52.8	63.6	136.1	103.8	150.1	65.3	92.6	54.3	116.8	1010.3
Rain	0	0	8.1	52	63.6	136.1	103.8	150.1	65.3	90	42.4	0	711.4
Snow	40.8	72.7	53.3	0.8	0	0	0	0	0	2.6	11.9	116.8	298.9
Snow Melt and Rain	6	0	25.43	234.5	88.1	136.1	103.8	150.1	65.3	92.6	48.83	0	950.79
1973													
Precipitation	40.5	33.7	63.6	81.9	65.6	191.4	98.1	48.2	35.2	82.4	64.3	69.8	874.7
Rain	10.2	0	28	73	65.6	191.4	98.1	48.2	35.2	82.4	36.3	12.2	680.6
Snow	30.3	33.7	35.6	8.9	0	0	0	0	0	0	28	57.6	194.1
Snow Melt and Rain	40.14	0	212.8	89.08	65.6	191.4	98.1	48.2	35.2	82.4	48.76	25.35	936.97
1974													
Precipitation	55.9	41.4	48.5	93.2	127.4	47.1	70.9	71.2	94.9	48.6	71.9	45.4	816.4
Rain	11.4	0	0.8	91.9	127.4	47.1	70.9	71.2	94.9	45.8	58.9	8.7	629
Snow	44.5	41.4	47.7	1.3	0	0	0	0	0	2.8	13	36.7	187.4
Snow Melt and Rain	34.56	0	75.22	189.2	127.4	47.1	70.9	71.2	94.9	48.6	64.36	18.08	841.54
1975													
Precipitation	67.5	35.3	40.5	39.8	21.6	44.3	81.1	28.7	76.7	59.7	74.7	50.6	620.5
Rain	0	1.3	17.8	3	21.6	44.3	81.1	28.7	76.7	59.7	52.6	0	386.8
Snow	67.5	34	22.7	36.8	0	0	0	0	0	0	22.1	50.6	233.7
Snow Melt and Rain	19.5	11.21	26.54	160.7	21.6	44.3	81.1	28.7	76.7	59.7	74.7	0	604.76
1976													
Precipitation	40	74	111	11.4	94.9	50.9	88.9	57.8	77	31.5	21	69.5	727.9
Rain	0	0	36.1	11.4	94.9	50.9	88.9	57.8	77	25.4	0	0	442.4
Snow	40	74	74.9	0	0	0	0	0	0	6.1	21	69.5	285.5
Snow Melt and Rain	0	0.9	147.7	138.4	94.9	50.9	88.9	57.8	77	31.5	14.4	0	702.4
1977													
Precipitation	53.1	31.2	32	45.2	25.7	55.1	45.5	81	87.1	67.4	123.8	74.1	721.2
Rain	0	5.8	5.1	43.7	25.7	55.1	45.5	81	87.1	47.1	73.7	0	469.8
Snow	53.1	25.4	26.9	1.5	0	0	0	0	0	20.3	50.1	74.1	251.4
Snow Melt and Rain	0	14.32	175.6	45.2	25.7	55.1	45.5	81	87.1	67.4	76.91	0	673.81
1978													

Precipitation	49	1.6	23.8	73.7	34.4	55.9	57.2	107.5	80.4	58.7	54.4	47.9	644.5
Rain	0	0	0	43.2	34.4	55.9	57.2	107.5	80.4	58.7	14.5	0	451.8
Snow	49	1.6	23.8	30.5	0	0	0	0	0	0	39.9	47.9	192.7
Snow Melt and Rain	0	0	14.7	204.2	84.57	55.9	57.2	107.5	80.4	58.7	20.1	3.9	687.19
1979													
Precipitation	99.5	24.6	10.5	65.5	91.4	30.4	87.4	58.8	112.6	112.5	73.4	26	792.6
Rain	0	0	6.5	45.3	91.4	30.4	87.4	55	112.6	108.4	62.4	3.5	602.9
Snow	99.5	24.6	4	20.2	0	0	0	3.8	0	4.1	11	22.5	189.7
Snow Melt and Rain	6	0.9	146.3	125.2	91.4	30.4	87.4	55	112.6	112.5	70.4	17.43	855.53
1980													
Precipitation	60	21	52.2	67	46.8	143.3	102.2	77.7	86.5	104.6	49.4	88.6	899.3
Rain	0	0	44	63.8	46.8	143.3	102.2	77.7	86.5	104.6	18.8	6.3	694
Snow	60	21	8.2	3.2	0	0	0	0	0	0	30.6	82.3	205.3
Snow Melt and Rain	0	0	118.5	93.32	46.8	143.3	102.2	77.7	86.5	104.6	40.2	12.46	825.53
1981													
Precipitation	19.3	41.2	46.5	72.8	79	93	76.2	117.2	136.6	71	35.5	56.8	845.1
Rain	0	13.4	20	72.8	79	93	76.2	117.2	136.6	53.8	23.1	1.2	686.3
Snow	19.3	27.8	26.5	0	0	0	0	0	0	17.2	12.4	55.6	158.8
Snow Melt and Rain	6.9	133.9	51.5	72.8	79	93	76.2	117.2	136.6	71	23.1	10.22	871.47
1982													
Precipitation	79.4	36.3	48.1	43.4	26.6	113	64.2	36	130.1	48.4	88.4	107.4	821.3
Rain	0	0	17.2	40.4	26.6	113	64.2	36	130.1	48.4	55.8	52.8	584.5
Snow	79.4	36.3	30.9	3	0	0	0	0	0	0	32.6	54.6	236.8
Snow Melt and Rain	0	0	78.05	188.1	26.6	113	64.2	36	130.1	48.4	60.61	115	860.11
1983													
Precipitation	59.8	56.4	60	73.4	120.4	34.6	40.6	113.8	90.8	86.2	129	108.6	973.6
Rain	3.6	0	40.2	47.2	120.4	34.6	40.6	105	90.8	73	15.8	0	571.2
Snow	56.2	56.4	19.8	26.2	0	0	0	8.8	0	13.2	113.2	108.6	402.4
Snow Melt and Rain	5.12	13.8	121.7	129.2	120.4	34.6	40.6	105	90.8	73	91.07	0	825.24
1984													
Precipitation	46.8	63.4	35.2	93.2	103.6	67.6	84.3	50.4	62.6	64.6	66.8	69	807.5
Rain	1.2	21.8	5.8	93.2	103.6	67.6	84.3	50.4	62.6	64.6	29	10.6	594.7
Snow	45.6	41.6	29.4	0	0	0	0	0	0	0	37.8	58.4	212.8
Snow Melt and Rain	2.1	99.08	32.69	250.9	103.6	67.6	84.3	50.4	62.6	64.6	66.8	25.8	910.43
1985													
Precipitation	69.4	65.8	83.2	64.8	45.2	76.2	110.2	91	53	57.4	79.8	74.9	870.9

Rain		0	32.6	30	36.6	45.2	76.2	110.2	91	53	57.4	44.6	14	590.8
Snow		69.4	33.2	53.2	28.2	0	0	0	0	0	0	35.2	60.9	280.1
Snow Melt and Rain		0	46.87	99.06	166.5	45.2	76.2	110.2	91	53	57.4	64.6	18.13	828.13
Surface Runoff		30.51	18.23	30.75	112.2	104	24.96	16.88	12.87	13.95	10.65	16.76	24.33	416.09
	1986													
Precipitation		65.6	22	82.8	53	151	70	78.8	78	98.2	52.4	13.6	59.4	824.8
Rain		17.4	8.6	19.6	53	151	70	78.8	78	98	52.2	8.6	1	636.2
Snow		48.2	13.4	63.2	0	0	0	0	0	0.2	0.2	5	58.4	188.6
Snow Melt and Rain		38.38	10.15	193.8	53	151	70	78.8	78	98	52.4	13.6	4.9	842.08

Table 10. Monthly and annual potential and actual evapotranspiration in the Severn River drainage basin.

(All values in mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1954													
Potential Evapotranspiration	0	0	0	0	22.1	103.9	131	104	55.55	21.3	0	0	438.37
Actual Evapotranspiration	0	0	0	0	22.1	103.9	106	67.24	55.55	20.8	0	0	376.1
1955													
Potential Evapotranspiration	0	0	0	13.3	55.1	115.4	128	113.9	50.96	18.5	0	0	495.5
Actual Evapotranspiration	0	0	0	13.3	55.1	114.7	128	113.9	50.96	18.5	0	0	494.72
1956													
Potential Evapotranspiration	0	0	0	0	0	107	121	106.6	42.78	23.8	0	0	401.62
Actual Evapotranspiration	0	0	0	0	0	107	62.5	79.72	42.78	23.8	0	0	315.82
1957													
Potential Evapotranspiration	0	0	0	0	34.1	86.52	133	102.4	63.7	27.1	0	0	446.3
Actual Evapotranspiration	0	0	0	0	34.1	86.52	133	99.12	34.18	27.1	0	0	413.55
1958													
Potential Evapotranspiration	0	0	0	0	23.4	81.31	124	97.08	65.68	21.8	0	0	412.81
Actual Evapotranspiration	0	0	0	0	23.4	81.32	109	62.77	65.68	21.8	0	0	364.36
1959													
Potential Evapotranspiration	0	0	0	0	32.6	91.21	129	105.1	63.71	0	0	0	421.34
Actual Evapotranspiration	0	0	0	0	32.6	91.21	128	100.6	63.71	0	0	0	415.79
1960													
Potential Evapotranspiration	0	0	0	0	55.2	103.4	119	109.3	59.9	11.1	0	0	458.02
Actual Evapotranspiration	0	0	0	0	55.2	103.4	77.1	77.14	50.87	11.1	0	0	374.79
1961													
Potential Evapotranspiration	0	0	0	0	40.5	96.1	135	107.6	54.68	10.8	0	0	444.2
Actual Evapotranspiration	0	0	0	0	40.5	96.11	76.4	51.24	54.68	10.8	0	0	329.72
1962													
Potential Evapotranspiration	0	0	0	0	38.5	111.5	120	101.3	58.8	25.7	0	0	455.41
Actual Evapotranspiration	0	0	0	0	38.5	111.6	100	33.46	55.32	25.7	0	0	365

1963													
Potential Evapotranspiration	0	0	0	0	23.1	98.37	134	102.3	51.28	45.9	0	0	454.69
Actual Evapotranspiration	0	0	0	0	23.1	98.38	70.4	50.06	51.21	39.8	0	0	332.94
1964													
Potential Evapotranspiration	0	0	0	0	57.5	93.22	131	92.38	55.7	13.3	0	0	442.8
Actual Evapotranspiration	0	0	0	0	57.5	93.23	101	86.97	55.7	13.3	0	0	407.75
1965													
Potential Evapotranspiration	0	0	0	0	51	103.6	110	97.27	50.7	18.6	0	0	431.03
Actual Evapotranspiration	0	0	0	0	51	103.6	110	93.7	50.7	18.6	0	0	427.32
1966													
Potential Evapotranspiration	0	0	0	0	33.2	99.09	128	101.6	66.37	0	0	0	428.8
Actual Evapotranspiration	0	0	0	0	33.2	99.09	128	101.6	66.37	0	0	0	428.74
1967													
Potential Evapotranspiration	0	0	0	0	8.71	98.36	120	104.9	77.37	9.64	0	0	418.59
Actual Evapotranspiration	0	0	0	0	8.71	98.38	68.2	71.38	45.27	9.64	0	0	301.6
1968													
Potential Evapotranspiration	0	0	0	0	59.5	95.8	108	90.09	80.51	19.5	0	0	453.38
Actual Evapotranspiration	0	0	0	0	59.5	86.81	108	90.09	59.25	19.5	0	0	423.13
1969													
Potential Evapotranspiration	0	0	0	0	33.3	73.35	130	119.3	44.66	0	0	0	400.87
Actual Evapotranspiration	0	0	0	0	33.3	73.35	111	80.39	44.66	0	0	0	342.52
1970													
Potential Evapotranspiration	0	0	0	0	21	104.4	131	109.3	57.79	23.4	0	0	446.95
Actual Evapotranspiration	0	0	0	0	21	104.4	130	97.34	57.79	23.4	0	0	433.99
1971													
Potential Evapotranspiration	0	0	0	0	45.9	106.5	110	103.1	64.41	25.1	0	0	455.4
Actual Evapotranspiration	0	0	0	0	45.9	106.5	98.3	52.16	49.21	25.1	0	0	377.14
1972													
Potential Evapotranspiration	0	0	0	0	60.1	108.2	114	107.4	44.37	0	0	0	434.29
Actual Evapotranspiration	0	0	0	0	60.1	108.2	64.6	61.21	44.37	0	0	0	338.37
1973													
Potential Evapotranspiration	0	0	0	0	42.6	90.63	121	123.5	55.68	25.3	0	0	458.48

Actual Evapotranspiration	0	0	0	0	42.6	90.63	121	79.32	55.68	25.3	0	0	414.32
1974													
Potential Evapotranspiration	0	0	0	0	29.7	94.05	136	102.4	37.18	0	0	0	398.86
Actual Evapotranspiration	0	0	0	0	29.7	94.05	136	102.4	37.18	0	0	0	398.87
1975													
Potential Evapotranspiration	0	0	0	0	56.9	110.6	126	101.8	51.28	18.2	0	0	464.62
Actual Evapotranspiration	0	0	0	0	56.9	110.6	126	101.8	51.28	18.2	0	0	464.63
1976													
Potential Evapotranspiration	0	0	0	0	47.9	106.2	125	106.8	59.55	5.46	0	0	450.93
Actual Evapotranspiration	0	0	0	0	47.9	106.2	121	72.08	28.96	5.46	0	0	381.76
1977													
Potential Evapotranspiration	0	0	0	0	81.8	100	119	88.56	58.17	31.1	0	0	478.83
Actual Evapotranspiration	0	0	0	0	81.8	42.19	119	88.56	51.32	31.1	0	0	414.17
1978													
Potential Evapotranspiration	0	0	0	0	66.5	84.6	123	95.51	53.59	10.2	0	0	433.08
Actual Evapotranspiration	0	0	0	0	66.5	84.6	123	95.22	53.59	10.2	0	0	432.78
1979													
Potential Evapotranspiration	0	0	0	0	42.4	101.3	133	96.29	48.72	0	0	0	421.8
Actual Evapotranspiration	0	0	0	0	42.4	101.3	106	84.48	48.72	0	0	0	382.57
1980													
Potential Evapotranspiration	0	0	0	0	70.8	88.05	126	109.2	43.65	0	0	0	437.33
Actual Evapotranspiration	0	0	0	0	70.8	67.62	82.7	84.7	43.65	0	0	0	349.52
1981													
Potential Evapotranspiration	0	0	0	0	43.5	91.82	135	113.9	53.98	11.5	0	0	449.82
Actual Evapotranspiration	0	0	0	0	43.5	91.82	134	99.93	53.98	11.5	0	0	434.71
1982													
Potential Evapotranspiration	0	0	0	0	71	79.03	125	96.5	61.86	20.2	0	0	453.86
Actual Evapotranspiration	0	0	0	0	71	79.03	125	96.5	61.87	20.2	0	0	453.86
1983													
Potential Evapotranspiration	0	0	0	0	11	97.76	135	120.4	62.49	20.9	0	0	447.71
Actual Evapotranspiration	0	0	0	0	11	97.76	135	113.9	62.49	20.9	0	0	441.17

1984													
Potential Evapotranspiration	0	0	0	21.36	44.2	100.5	126	119.8	44.05	21.6	0	0	477.21
Actual Evapotranspiration	0	0	0	21.36	44.2	100.5	126	100.6	44.05	21.6	0	0	457.95
1985													
Potential Evapotranspiration	0	0	0	0	53.6	91.27	118	102.9	59.6	18.2	0	0	443.54
Actual Evapotranspiration	0	0	0	0	53.6	91.27	118	69.55	59.6	18.2	0	0	410.22
1986													
Potential Evapotranspiration	0	0	0	0	71.9	91.73	121	102.7	47.3	9.16	0	0	444.04
Actual Evapotranspiration	0	0	0	0	71.9	91.74	118	71.06	47.3	9.16	0	0	409.19
1987													
Potential Evapotranspiration	0	0	0	11.96	62.5	108.5	122	96.9	67.63	2.15	0	0	471.66
Actual Evapotranspiration	0	0	0	11.96	62.5	98.68	64.6	96.9	66.85	2.15	0	0	403.62
1988													
Potential Evapotranspiration	0	0	0	0	54.2	107.8	130	111.7	58.83	0	0	0	462.88
Actual Evapotranspiration	0	0	0	0	54.2	107.8	118	35.07	58.83	0	0	0	373.49
1989													
Potential Evapotranspiration	0	0	0	0	56.3	93.28	138	102.8	58.4	17	0	0	465.8
Actual Evapotranspiration	0	0	0	0	56.3	93.29	57.4	78.75	58.4	17	0	0	361.12
1990													
Potential Evapotranspiration	0	0	0	0	47.6	95.57	129	113.5	50.57	3.46	0	0	440.04
Actual Evapotranspiration	0	0	0	0	47.6	95.58	83.5	113.5	42.73	3.46	0	0	386.39
1991													
Potential Evapotranspiration	0	0	0	2.24	61.9	115.1	127	114.3	50.46	0	0	0	470.79
Actual Evapotranspiration	0	0	0	2.24	61.9	111	109	61.92	50.46	0	0	0	396.26

Table 11. Monthly and annual potential and actual evapotranspiration in the Winisk River drainage basin.

(All values in mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1970													
Potential Evapotranspiration	0	0	0	0	0	73.26	117.1	100.7	60.17	33.16	0	0	384.45
Actual Evapotranspiration	0	0	0	0	0	73.26	117.1	87.09	57.35	33.16	0	0	368

Table 12. Monthly and annual potential and actual evapotranspiration in the Attawapiskat River drainage basin.

(All values in mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1947													
Potential Evapotranspiration	0	0	0	0	12.99	97.75	135.2	117	57.94	45.69	0	0	466.64
Actual Evapotranspiration	0	0	0	0	12.99	97.76	132.1	117	57.94	44.78	0	0	462.56
1948													
Potential Evapotranspiration	0	0	0	0	45.58	100.3	127.9	112.6	81.64	32.07	0	0	500.07
Actual Evapotranspiration	0	0	0	0	45.59	99.25	127.9	112.6	78.43	30.45	0	0	494.22
1949													
Potential Evapotranspiration	0	0	0	0	50.83	115.1	123.6	106.6	50.23	16.61	0	0	463.03
Actual Evapotranspiration	0	0	0	0	50.83	115.1	76.62	106.6	50.23	16.61	0	0	416.04
1950													
Potential Evapotranspiration	0	0	0	0	45.3	86.99	123.9	100.2	66.75	20.23	0	0	443.37
Actual Evapotranspiration	0	0	0	0	45.3	86.99	123.9	73.7	24.6	20.23	0	0	374.7
1951													
Potential Evapotranspiration	0	0	0	0	71.59	108.5	121.8	103.4	55.6	9.1	0	0	470.02
Actual Evapotranspiration	0	0	0	0	71.59	108.5	121.8	80.92	55.6	9.1	0	0	447.51
1952													
Potential Evapotranspiration	0	0	0	13.27	65.33	101.7	126.3	109.9	60.19	0	0	0	476.68
Actual Evapotranspiration	0	0	0	13.27	65.33	101.7	126.3	108.4	60.19	0	0	0	475.24
1953													
Potential Evapotranspiration	0	0	0	0	40.59	99.98	124.9	120.7	53.5	31.76	0	0	471.38
Actual Evapotranspiration	0	0	0	0	40.59	99.98	118.2	36.24	35.98	22.56	0	0	353.52
1954													
Potential Evapotranspiration	0	0	0	0	25.73	111.1	130.8	107.1	57.3	23.18	0	0	455.26
Actual Evapotranspiration	0	0	0	0	25.73	111.1	125.8	73.37	57.3	23.18	0	0	416.49
1955													
Potential Evapotranspiration	0	0	0	14.17	59.96	126.3	135.7	115.6	49.75	20.46	0	0	521.99
Actual Evapotranspiration	0	0	0	14.17	59.96	126.3	101.7	91.4	49.75	20.46	0	0	463.75

1956													
Potential Evapotranspiration	0	0	0	0	10.58	112.6	122.1	105.1	46.31	32.44	0	0	429.21
Actual Evapotranspiration	0	0	0	0	10.58	112.7	74.49	86.08	46.05	32.44	0	0	362.29
1957													
Potential Evapotranspiration	0	0	0	0	47.21	95.07	134.8	102.8	64.62	28.97	0	0	473.45
Actual Evapotranspiration	0	0	0	0	47.21	95.07	131.9	72.71	44.51	26.89	0	0	418.26
1958													
Potential Evapotranspiration	0	0	0	0	35.94	90.83	126.4	99.23	65.26	23.82	0	0	441.47
Actual Evapotranspiration	0	0	0	0	35.94	90.84	93.09	92.43	65.26	23.82	0	0	401.39
1959													
Potential Evapotranspiration	0	0	0	0	41.25	101.3	133.3	107.9	67.73	0	0	0	451.47
Actual Evapotranspiration	0	0	0	0	41.25	101.3	133.3	107.9	67.73	0	0	0	451.47
1960													
Potential Evapotranspiration	0	0	0	0	62.68	108.5	122.1	113.4	61.31	16.72	0	0	484.74
Actual Evapotranspiration	0	0	0	0	62.68	108.5	74.78	44.61	53.63	16.72	0	0	360.88
1961													
Potential Evapotranspiration	0	0	0	0	45.32	100.2	136.5	112.4	59.61	16.55	0	0	470.54
Actual Evapotranspiration	0	0	0	0	45.32	100.2	59.42	56.3	59.61	16.55	0	0	337.41
1962													
Potential Evapotranspiration	0	0	0	0	52.99	114.8	125.2	102.1	55.72	29.09	0	0	479.86
Actual Evapotranspiration	0	0	0	0	52.99	114.8	66.36	93.64	55.72	29.09	0	0	412.65
1963													
Potential Evapotranspiration	0	0	0	0	40.35	105.3	138.4	102.2	54.11	48.04	0	0	488.47
Actual Evapotranspiration	0	0	0	0	40.35	105.3	138.4	71.74	37.34	36.82	0	0	430
1964													
Potential Evapotranspiration	0	0	0	0	68.73	99.07	132.5	92.13	57.6	19.53	0	0	469.59
Actual Evapotranspiration	0	0	0	0	68.73	98.38	102.5	92.13	57.6	19.53	0	0	438.84
1965													
Potential Evapotranspiration	0	0	0	0	59.25	107.5	113	94.95	52.34	19.87	0	0	446.92
Actual Evapotranspiration	0	0	0	0	59.25	107.5	95.95	59.1	52.34	19.87	0	0	394.02
1966													
Potential Evapotranspiration	0	0	0	0	34.84	107.7	132.4	103.7	66.82	8.51	0	0	453.97

Actual Evapotranspiration	0	0	0	0	34.84	107.7	132.4	52.55	66.82	8.51	0	0	402.82
1967													
Potential Evapotranspiration	0	0	0	0	21.31	106.8	123.6	107.6	76.14	13.79	0	0	449.26
Actual Evapotranspiration	0	0	0	0	21.31	106.8	121.3	50.6	58.33	13.79	0	0	372.17
1968													
Potential Evapotranspiration	0	0	0	0	66.25	99.91	112.1	95.3	82.03	22.18	0	0	477.78
Actual Evapotranspiration	0	0	0	0	66.25	99.36	112.1	94.89	70.11	22.18	0	0	464.9
1969													
Potential Evapotranspiration	0	0	0	0	41.56	76.14	131.8	123.1	51.32	0	0	0	423.97
Actual Evapotranspiration	0	0	0	0	41.56	76.14	131.9	107	51.32	0	0	0	407.88
1970													
Potential Evapotranspiration	0	0	0	0	34.88	107.7	133.3	110.6	58.86	30.96	0	0	476.32
Actual Evapotranspiration	0	0	0	0	34.88	107.7	122	110.6	58.86	30.96	0	0	464.98
1971													
Potential Evapotranspiration	0	0	0	0	47.89	111.5	113.2	104	66.78	31.29	0	0	474.68
Actual Evapotranspiration	0	0	0	0	47.89	111.5	113.2	104.1	66.78	31.29	0	0	474.7
1972													
Potential Evapotranspiration	0	0	0	0	67.02	112.8	117.4	109.2	50.32	0	0	0	456.66
Actual Evapotranspiration	0	0	0	0	67.02	112.8	117.4	107.2	50.32	0	0	0	454.63
1973													
Potential Evapotranspiration	0	0	0	0	44.55	99.14	126	122.5	57.27	32.42	0	0	481.85
Actual Evapotranspiration	0	0	0	0	44.55	99.14	124.1	122.5	54.75	32.42	0	0	477.42
1974													
Potential Evapotranspiration	0	0	0	0	30.7	102.8	137.6	103.2	45.61	0	0	0	419.9
Actual Evapotranspiration	0	0	0	0	30.7	102.8	137.6	103.2	45.61	0	0	0	419.9
1975													
Potential Evapotranspiration	0	0	0	0	70.4	115.9	127.9	103.3	54.21	21.2	0	0	492.89
Actual Evapotranspiration	0	0	0	0	70.4	115.9	127.9	103.3	54.22	21.2	0	0	492.89
1976													
Potential Evapotranspiration	0	0	0	0	49.07	114.9	129.7	111.8	58.73	9.56	0	0	473.66
Actual Evapotranspiration	0	0	0	0	49.07	114.7	126.1	111.8	58.73	9.56	0	0	469.84

1977													
Potential Evapotranspiration	0	0	0	5.89	85.08	102.4	122.4	89.67	61	31.45	0	0	497.9
Actual Evapotranspiration	0	0	0	5.89	85.08	97.61	110	89.67	61	31.4	0	0	480.62
1978													
Potential Evapotranspiration	0	0	0	0	69.48	92.01	126.1	101.7	54.11	16.86	0	0	460.23
Actual Evapotranspiration	0	0	0	0	69.48	92.02	110.1	101.7	54.11	16.86	0	0	444.26
1979													
Potential Evapotranspiration	0	0	0	0	53.23	108.7	132.9	95.88	53.36	4.74	0	0	448.85
Actual Evapotranspiration	0	0	0	0	53.23	108.7	128.9	88.71	53.36	4.74	0	0	437.72
1980													
Potential Evapotranspiration	0	0	0	0	75.19	97.67	130.9	113.1	46.3	0	0	0	463.21
Actual Evapotranspiration	0	0	0	0	75.2	89.54	71.86	68.27	46.3	0	0	0	351.18
1981													
Potential Evapotranspiration	0	0	0	0	48.16	96.52	140.2	119.4	55.24	12.55	0	0	472.05
Actual Evapotranspiration	0	0	0	0	48.16	96.53	75.06	51.5	55.24	12.55	0	0	339.04
1982													
Potential Evapotranspiration	0	0	0	0	76.06	86.39	130.2	94.94	62.22	24.55	0	0	474.37
Actual Evapotranspiration	0	0	0	0	76.06	86.39	130.2	91.43	62.22	24.55	0	0	470.87
1983													
Potential Evapotranspiration	0	0	0	0	21.99	109.3	138.6	122.9	66.91	23.89	0	0	483.65
Actual Evapotranspiration	0	0	0	0	21.99	109.3	126.5	71.67	64.81	23.89	0	0	418.15
1984													
Potential Evapotranspiration	0	0	0	25.38	50.45	104.4	130.7	124.6	48.81	25.55	0	0	509.84
Actual Evapotranspiration	0	0	0	25.38	50.45	104.1	129.6	100.2	48.81	25.55	0	0	484.1
1985													
Potential Evapotranspiration	0	0	0	0	57.14	96.44	120.8	107.1	61.3	22.42	0	0	465.2
Actual Evapotranspiration	0	0	0	0	57.14	96.44	120.8	106.5	61.3	22.42	0	0	464.58
1986													
Potential Evapotranspiration	0	0	0	6.46	80.68	95.19	127.9	106.6	50.04	11.89	0	0	478.73
Actual Evapotranspiration	0	0	0	6.46	80.69	84.69	96.44	61.55	50.04	11.89	0	0	391.75
1987													
Potential Evapotranspiration	0	0	0	26.18	72.1	110.6	125	99.86	69.29	3.9	0	0	506.97

Actual Evapotranspiration	0	0	0	26.18	72.11	106.1	119.7	99.86	69.3	3.9	0	0	497.2
1988													
Potential Evapotranspiration	0	0	0	4.8	67.95	111.2	133.4	112.8	58.19	8.46	0	0	496.89
Actual Evapotranspiration	0	0	0	4.8	67.95	108.1	88.03	99.68	58.19	8.46	0	0	435.25

Table 13. Monthly and annual potential and actual evapotranspiration in the Albany River drainage basin.

(All values in mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1987													
Potential Evapotranspiration	0	0	0	0	73.2	91.7	107	93.86	64.66	7.95	0	0	437.93
Actual Evapotranspiration	0	0	0	0	73.2	72.3	66.3	93.86	64.66	7.95	0	0	378.28
1988													
Potential Evapotranspiration	0	0	0	0	60.6	77.1	132	104.6	66.29	15.93	0	0	456.19
Actual Evapotranspiration	0	0	0	0	60.6	11.3	55.3	27.7	66.21	15.93	0	0	237

Table 14. Monthly and annual potential and actual evapotranspiration in the Moose River drainage basin.

(All values in mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1982													
Potential Evapotranspiration	0	0	0	0	68.54	94.46	115.4	90.9	65.43	36.19	0	0	470.93
Actual Evapotranspiration	0	0	0	0	68.54	94.46	115.4	87.86	65.43	36.19	0	0	467.89
1983													
Potential Evapotranspiration	0	0	0	0	28.6	111.7	117.4	106.5	67.23	27.92	0	0	459.33
Actual Evapotranspiration	0	0	0	0	28.6	111.7	72.58	56.53	67.23	27.92	0	0	364.51
1984													
Potential Evapotranspiration	0	0	0	14.38	45.54	92.04	122.6	108.4	56.01	34.56	0	0	473.5
Actual Evapotranspiration	0	0	0	14.38	45.54	92.04	122.6	108.4	56.01	34.56	0	0	473.5
1985													
Potential Evapotranspiration	0	0	0	0	47.67	94.91	108	104.9	69.55	31.6	0	0	456.6
Actual Evapotranspiration	0	0	0	0	47.67	94.91	108	104.9	69.55	31.6	0	0	456.6
1986													
Potential Evapotranspiration	0	0	0	1.43	68.27	86.13	118.3	102.4	54.64	17.13	0	0	448.24
Actual Evapotranspiration	0	0	0	1.43	68.27	86.13	118.3	102.4	54.64	17.13	0	0	448.24
1987													
Potential Evapotranspiration	0	0	0	15.45	65.8	98.51	116.1	102.1	67.77	13.93	0	0	479.67
Actual Evapotranspiration	0	0	0	15.45	65.8	85.58	103.6	102.1	67.77	13.93	0	0	454.31
1988													
Potential Evapotranspiration	0	0	0	0	63.09	82.87	123.6	103.9	66.59	15.02	0	0	455.02
Actual Evapotranspiration	0	0	0	0	63.09	82.87	116.9	78.61	66.59	15.02	0	0	423.07
1989													
Potential Evapotranspiration	0	0	0	0	62.1	95.86	115.9	95.85	70.19	29.02	0	0	468.87
Actual Evapotranspiration	0	0	0	0	62.1	95.86	94.6	60.67	70.19	29.02	0	0	412.45
1990													
Potential Evapotranspiration	0	0	0	0	42.89	94.34	129.4	104.8	54.6	21.81	0	0	447.75
Actual Evapotranspiration	0	0	0	0	42.89	94.34	129.4	89.52	54.6	21.81	0	0	432.51

1991													
Potential Evapotranspiration	0	0	0	0	61.34	101.8	118.1	106.8	57.93	19.49	0	0	465.41
Actual Evapotranspiration	0	0	0	0	61.34	101.8	69.65	90.23	57.93	19.49	0	0	400.43
1992													
Potential Evapotranspiration	0	0	0	0	66	84.45	104	96.09	72.3	14.1	0	0	436.97
Actual Evapotranspiration	0	0	0	0	66	84.45	104	96.09	72.3	14.1	0	0	436.97
1993													
Potential Evapotranspiration	0	0	0	0	64.9	103.7	126.7	111.1	54.14	10.15	0	0	470.71
Actual Evapotranspiration	0	0	0	0	64.9	61.09	126.2	82.61	54.14	10.15	0	0	399.05

Table 15. Monthly and annual potential and actual evapotranspiration in the Montreal River drainage basin.

(All values in mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1967													
Potential Evapotranspiration	0	0	0	8.42	48.32	113.5	122	99.53	70.73	32.5	0	0	494.87
Actual Evapotranspiration	0	0	0	8.42	48.32	113.5	86.78	79.84	51.43	32.5	0	0	420.7
1968													
Potential Evapotranspiration	0	0	0	31.92	67.26	96.51	122.6	99.56	78.02	44.9	0	0	540.78
Actual Evapotranspiration	0	0	0	31.92	67.26	96.51	119	44.03	78.02	43.9	0	0	480.59
1969													
Potential Evapotranspiration	0	0	0	9.35	63.44	97.21	124.4	119.8	63.33	26.3	0	0	503.8
Actual Evapotranspiration	0	0	0	9.35	63.44	95.19	89.12	51.86	63.33	26.3	0	0	398.56
1970													
Potential Evapotranspiration	0	0	0	11	56.32	102.5	133.7	114.43	66.26	43.5	0	0	527.66
Actual Evapotranspiration	0	0	0	11	56.32	102.5	83.3	25.23	66.26	42.3	0	0	386.86
1972													
Potential Evapotranspiration	0	0	0	0	80.28	102.3	123.3	101.95	64.09	19.9	0	0	491.83
Actual Evapotranspiration	0	0	0	0	80.28	73.74	89	101.95	64.09	19.9	0	0	428.99
1973													
Potential Evapotranspiration	0	0	0	17.08	60.58	109.6	127.8	121.17	65.09	39.9	0	0	541.25
Actual Evapotranspiration	0	0	0	17.08	60.58	109.6	116.7	88.6	48.7	39.9	0	0	481.16
1977													
Potential Evapotranspiration	0	0	0	17.78	88.92	95.8	127.9	98.65	60.3	26.2	1	0	516.87
Actual Evapotranspiration	0	0	0	17.78	60.89	72.8	41.2	71.4	57.9	26.2	1.36	0	349.49
1978													
Potential Evapotranspiration	0	0	0	0	88.7	96.05	123.5	108.21	58.04	33.2	0	0	507.77
Actual Evapotranspiration	0	0	0	0	88.7	96.05	121.3	70.65	58.04	33.2	0	0	467.92
1979													
Potential Evapotranspiration	0	0	0	5.51	73.2	109	127.1	93.02	68.9	27.7	0	0	504.41
Actual Evapotranspiration	0	0	0	5.51	73.2	109	127.1	60.25	68.81	27.7	0	0	471.55

1982													
Potential Evapotranspiration	0	0	0	0	86.88	88.39	134.5	89.44	62.17	42.9	0	0	504.32
Actual Evapotranspiration	0	0	0	0	86.88	82.05	27.06	78	62.17	42.9	0	0	379.08
1983													
Potential Evapotranspiration	0	0	0	16.25	52.07	107.6	132.9	108.7	67.36	27.3	0	0	512.11
Actual Evapotranspiration	0	0	0	16.25	52.07	62.12	77.5	27.7	38	27.3	0	0	300.91

Table 16. Monthly and annual potential and actual evapotranspiration in the Petawawa River drainage basin.

(All values in mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1966													
Potential Evapotranspiration	0	0	0	19.1	54.26	111.8	132.6	109.3	63.19	32.51	5	0	527.67
Actual Evapotranspiration	0	0	0	19.1	54.26	82.32	64.38	108.3	62.4	32.51	4.95	0	428.25
1967													
Potential Evapotranspiration	0	0	0	18.16	50.26	120.5	127.3	103.9	68.81	32.19	0	0	521.03
Actual Evapotranspiration	0	0	0	18.16	50.26	120.5	127.3	103.9	68.81	32.19	0	0	521.03
1968													
Potential Evapotranspiration	0	0	0	35.18	65.87	105.7	125.7	102.9	79.5	42.72	0	0	557.55
Actual Evapotranspiration	0	0	0	35.18	65.87	97.83	100.5	48.85	72.54	42.72	0	0	463.47
1969													
Potential Evapotranspiration	0	0	0	26.02	61.56	99.11	123.2	118.9	70.87	32.32	5	0	536.61
Actual Evapotranspiration	0	0	0	26.02	61.56	99.11	45.43	56.59	70.72	32.32	4.57	0	396.31
1970													
Potential Evapotranspiration	0	0	0	21.25	68	104.4	128.9	111.2	69.86	37.27	3	0	544.42
Actual Evapotranspiration	0	0	0	21.25	68	104.4	128.9	108.2	69.86	37.27	3.48	0	541.38
1971													
Potential Evapotranspiration	0	0	0	13.83	74.51	108.7	116.6	104.5	79.88	50.94	0	0	548.93
Actual Evapotranspiration	0	0	0	13.83	74.51	61.96	39.6	70.17	62.62	38.7	0	0	361.39
1972													
Potential Evapotranspiration	0	0	0	3.78	80.43	100.7	126.2	104	70.6	22.56	0	0	508.3
Actual Evapotranspiration	0	0	0	3.78	80.43	100.7	126.2	104	70.6	22.56	0	0	508.3
1973													
Potential Evapotranspiration	0	0	4	21.71	64.3	113.9	129.1	122.1	67.46	42.53	0	0	565.15
Actual Evapotranspiration	0	0	4.03	21.71	64.3	113.9	129.1	56.49	38.56	42.53	0	0	470.62
1974													
Potential Evapotranspiration	0	0	0	25.96	60.52	110.5	125.5	111.6	62.36	25.46	0	0	521.78
Actual Evapotranspiration	0	0	0	25.96	60.52	110.5	75.32	73.11	62.36	25.46	0	0	433.2

1975													
Potential Evapotranspiration	0	0	0	2.29	90.65	114	132.6	112.8	61.82	34.76	10	0	558.58
Actual Evapotranspiration	0	0	0	2.29	90.65	44.94	81.1	28.7	61.82	34.76	9.67	0	353.93
1976													
Potential Evapotranspiration	0	0	0	35.28	64.32	122.1	121.7	105.1	65.9	19.58	0	0	533.94
Actual Evapotranspiration	0	0	0	35.28	64.32	120.6	88.9	57.8	65.9	19.58	0	0	452.36
1977													
Potential Evapotranspiration	0	0	1	30.96	91.56	99.53	128.4	99.3	66.89	26.68	2	0	545.8
Actual Evapotranspiration	0	0	0.69	30.96	91.56	58.6	45.84	81	66.89	26.68	1.76	0	403.98
1978													
Potential Evapotranspiration	0	0	0	3.89	88.9	104.5	127.6	110.8	61.48	27.29	0	0	524.4
Actual Evapotranspiration	0	0	0	3.89	88.9	89.86	64.6	107.8	61.48	27.29	0	0	443.84
1979													
Potential Evapotranspiration	0	0	0	18.66	77.74	109.5	129.5	104.7	69.38	29.78	5	0	543.93
Actual Evapotranspiration	0	0	0	18.66	77.74	100.1	87.4	55	69.38	29.78	4.76	0	442.81
1980													
Potential Evapotranspiration	0	0	0	33.6	80.79	90.29	126.5	116.7	62.18	22.95	0	0	533.06
Actual Evapotranspiration	0	0	0	33.6	80.79	90.29	126.5	82.33	62.18	22.95	0	0	498.68
1981													
Potential Evapotranspiration	0	0	0	31.96	70.86	110.4	129.5	107.8	66.37	22.27	1	0	540.5
Actual Evapotranspiration	0	0	0	31.96	70.86	110.4	82.88	107.8	66.37	22.27	1.36	0	493.85
1982													
Potential Evapotranspiration	0	0	0	13.35	90.9	96.93	127.1	95.53	71.61	39.67	3	0	537.76
Actual Evapotranspiration	0	0	0	13.35	90.9	96.93	70.22	41.35	71.61	39.67	2.63	0	426.66
1983													
Potential Evapotranspiration	0	0	0	17.54	58.44	111.8	134.4	117.8	77.51	30.19	0	0	547.66
Actual Evapotranspiration	0	0	0	17.54	58.44	104.3	40.6	105	77.51	30.19	0	0	433.57
1984													
Potential Evapotranspiration	0	0	0	35.69	61.88	111.3	123.3	116	62.5	40.03	0	0	550.72
Actual Evapotranspiration	0	0	0	35.69	61.88	111.3	88.19	56.72	62.5	40.03	0	0	456.34
1985													
Potential Evapotranspiration	0	0	0	20.11	77.39	96.62	121.8	105.1	75.7	37.97	0	0	534.73

Actual Evapotranspiration	0	0	0	20.11	77.39	78.47	111.5	92.52	55.41	37.97	0	0	473.33
1986													
Potential Evapotranspiration	0	0	0	43.36	87.26	99	124.2	101.4	64.06	32.1	0	0	551.4
Actual Evapotranspiration	0	0	0	43.36	87.26	99	83.98	80.56	64.06	32.1	0	0	490.32

Table 17. Monthly and annual surface runoff in the Severn River drainage basin.

(All values in mm)

Surface Runoff	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1970	7.08	4.3	3.75	3.22	23	61.89	43.7	27.09	21.43	34.4	20.2	11.7	261.83
1971	7.86	5.56	5.17	4.98	36.9	30.48	29.7	30.17	16.62	17.1	14.7	11.1	210.31
1972	8.48	6.47	6.06	5.59	50	34.72	19.7	13.4	14.55	20.1	14.3	11	204.38
1973	8.34	6.05	5.76	5.37	50.4	35.39	36.7	19.88	20.15	29.8	25.1	18.4	261.33
1974	13.31	9.19	8.06	7.13	31.1	60.24	30.8	26.96	29.65	27.5	17.8	13.2	274.94
1975	10.1	7.33	6.76	10.31	56.9	44.53	37.5	52.47	38.68	37.7	27.2	18.9	348.39
1976	-	-	-	-	-	24.24	19.9	16.54	15.52	10.7	5.92	4.49	97.25
1977	3.7	2.92	2.9	7.63	24.1	11.98	12	23.21	25.78	18.5	15.5	10.8	158.99
1978	7.26	5.01	4.63	4.2	21.8	21.25	27.2	33.37	27.99	23	17.5	13.5	206.65
1979	10.73	7.26	6.14	6.52	39.8	36.05	26.9	19.39	17.28	20.5	18.8	12.5	221.82
1980	-	-	-	-	-	-	-	-	-	-	-	-	
1981	8.13	5.88	5.42	4.61	11.3	30.46	16.1	-	1.14	-	-	-	83.08
1982	-	-	-	-	-	47.19	41.1	37.32	25.68	28	20	13.2	212.48
1983	9.24	6.23	5.66	5.15	15.8	43.95	37.6	24.92	24.1	23	18.2	10.8	224.58
1984	7.89	6.33	4.98	5.02	20.7	25.86	21.2	16.05	16.73	16.2	14.9	11.4	167.22
1985	8.6	6.04	5.61	6.03	43.4	69.63	60.3	29.88	26.29	34.9	23	15.6	329.45
1986	10.56	7.16	6.68	6.55	50.7	30.32	19.9	17.53	24.41	23.7	16	10.4	223.94
1987	8.28	6.56	6.59	22.1	28.2	17.31	22.3	19.04	29.91	16.1	13.5	8.29	198.21
1988	5.89	4.66	4.76	4.88	44	22.97	14.1	11.07	10.21	13.3	9.64	7.03	152.51
1989	5.09	3.61	3.37	3.12	32.7	24.83	15.6	10.53	16.38	23.9	16.1	8.58	163.76
1990	5.23	3.98	4.4	4.3	29.8	33.62	21	13.26	10.63	12.3	10.6	9.48	158.46
1991	6.7	3.86	3.13	2.67	18.8	13.18	16.2	12.74	11.6	18.6	11.2	8.49	127.18
1992	6.94	5.77	5.79	5.58	32.7	44.5	26.5	31.03	26.74	21.7	13.9	9.09	230.18

Table 18. Monthly and annual surface runoff in the Winisk River drainage basin.

(All values in mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Surface Runoff													
1966	15.47	9.78	7.31	6.15	41.34	73.90	62.21	39.81	40.88	36.40	29.90	17.92	381.07
1967	10.89	6.46	5.71	5.27	15.23	61.17	37.42	22.28	12.36	10.38	10.30	7.81	205.28
1968	6.39	5.23	5.06	6.36	28.66	25.26	33.51	35.80	30.93	43.13	52.63	22.93	295.892
1969	13.55	8.97	7.08	6.73	46.75	43.07	52.10	35.12	42.95	79.23	42.55	24.02	402.12
1970	14.37	8.28	6.59	5.96	41.78	54.22	37.95	37.49	41.36	65.23	44.41	22.97	380.29
1971	14.49	8.95	7.22	6.58	76.15	53.95	30.31	42.65	29.17	45.93	29.25	15.93	360.59
1972	10.09	6.94	5.99	5.03	42.03	48.68	35.49	31.30	33.22	49.00	27.69	16.98	312.44
1973	11.15	7.52	6.89	6.11	65.61	64.54	65.51	32.83	22.35	24.58	20.36	15.33	342.78
1974							45.34	27.80	41.15	34.12	19.80	12.60	
1975	8.75	6.19	5.70	4.99	18.03	48.19	47.72	66.64	38.91	27.92	21.59	13.24	307.87
1976	9.10	6.57	5.76	9.62	58.17	38.71	25.83	16.03	10.73	9.45	7.05	5.61	202.63
1977	4.67	3.61	3.54	10.00	29.29	18.85	17.24	14.06	16.84	19.60	15.10	10.43	163.23
1978	7.10	5.21	5.16	4.87	24.11	15.86			1.48		6.25	14.46	
1979	11.00	7.47	6.50	16.33	49.58	33.87	25.74	26.86	26.00	30.54	26.08	18.28	278.25
1980	13.11	7.71	5.20	5.96	44.16	25.64	24.77	20.75	23.85	41.31	23.94	15.24	251.64
1981	11.13	7.63	6.82	7.56	62.37	43.55	25.17	13.88	9.31				
1982						62.95	54.25	33.20	27.73	33.08	25.97	16.84	
1983	11.21	7.45	6.16	4.56	10.89	28.59	27.02	18.46	16.60	21.06	17.86	13.47	183.33
1984	11.54	8.78	6.16	22.52	38.11	30.64	25.49	18.15	13.37	19.58	17.63	15.37	227.34
1985	12.92	9.16	7.10	7.64	119.20	126.40	79.96	37.71	29.94	36.32	25.36	17.30	509.01
1986	11.74	7.42	5.73	4.28	62.95	40.95	26.18	22.95	29.71	26.94	16.56	10.78	266.19
1987	8.31	6.28	6.01	20.60	30.00	24.29	19.87	15.84	32.63	24.65	20.03	12.52	221.03
1988	8.01	5.50	4.83	4.63	49.93	30.53	16.94	11.14	25.94	23.68	21.33	13.51	215.97
1989	9.21	6.05	4.95	3.89	17.49	30.67	22.38	13.21	14.87	24.87	25.15	15.44	188.18
1990	8.61	9.97	4.61	4.37	19.65	28.31	15.62	8.97	6.82	7.23	6.79	5.43	126.38
1991	9.07	7.40	3.91	3.87	17.67	16.12	11.15	9.73	9.99	21.01	11.44	8.13	129.49
1992	12.98	4.98	5.06	4.57	18.54	57.93	45.13	50.45	42.96	31.77	18.55	12.25	305.17
1993	8.29	5.38	4.60	3.84	12.07	12.90	17.83	15.61	17.40	36.98	24.59	8.16	167.65
1994	6.09	4.45	4.27	3.86	58.08	33.70	23.15	29.80	19.88	20.51	28.50	17.12	249.41

Table 19. Monthly and annual surface runoff in the Attawapiskat River drainage basin.

(All values in mm)

Surface Runoff	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1968	6.09	4.63	4.68	7.53	58.58	60.61	56.03	46	35.25	48.09	58.47	24.9	410.86
1969	14.73	8.16	5.63	4.67	79.08	69.18	91.77	37.32	45.84	71.89	33.81	18.51	480.6
1970	11.92	7.7	6.25	4.78	52.98	53.41	33.35	37.73	58.42	76.59	40.91	24.27	408.3
1971	13.96	7.95	5.83	8.2	134.6	47.28	26.94	59.83	19.72	55.64	35.96	15.98	431.92
1972	10.02	6.95	5.96	4.92	54.18	45.84	24.01	33.63	20.85	48.22	31.6	17.1	303.29
1973	9.24	5.99	5.7	6.68	74.48	47.1	51.09	12.53	14.34	22.52	18.18	12.77	280.6
1974	8.77	5.87	5.23	4.72	48.08	127.7	48.85	25.84	61.59	40.31	20.82	14.35	412.12
1975	11.09	8.18	7.76	7.25	47.97	57.01	53.03	81.49	34.23	22.34	18.74	9.04	358.13
1976	5.75	4.2	4.02	16.66	112.5	34.82	17.71	10.48	6.36	7.75	5.67	3.89	229.83
1977	4.37	3.34	3.31	23.48	51.8	32.4	37.82	27.83	45.63	29.05	15.53	10.65	285.2
1978	7.7	5.38	4.76	3.99	60.62	61.11	29.56	42.83	55.81	33.27	24.38	14.18	343.6
1979	8.49	5.66	5.13	7.31	52.97	47.82	33.25	38.47	60.1	49.92	45.57	21.44	376.13
1980	10.96	6.47	5.46	13.67	62.41	23.93	14.82	10.87	13.62	40.45	24.93	10.86	238.43
1981	6.35	4.3	4.33	4.11	54.88	41.58	22.72	8.84	5.63	8.77	16.83	9.97	188.32
1982	6.49	3.98	3.38	3.74	73.21	68.34	37.13	22.94	36.21	43.44	30.86	14.86	344.58
1983	8.61	5.54	4.92	4.73	23.85	30.89	52.35	21.75	10.35	15.71	15.18	11.87	205.72
1984	8.47	5.58	4.12	14.6	56.1	49.75	29.72	16.28	8.19	9.77	11.07	10.18	223.84
1985	8.49	5.98	5.19	6.28	107	81.58	58.49	32.66	39.82	66.92	43.18	19.58	475.18
1986	10.68	5.94	4.88	10.76	80.98	35.1	20.19	12.27	8.32	17.58	18.52	11.74	236.95
1987	7.23	4.64	4.57	12.95	41.94	23.41	20.73	26.47	34.99	22.72	17.19	11.03	227.86
1988	6.82	4.03	3.43	9.69	37.5	25.68	18.81	12.78	24.49	41.82	25.59	18.58	229.21
1989	11.11	6.31	4.63	3.45	44.4	49.25	27.97	16.6	19.54	28.44	17.45	8.92	238.08
1990	5.85	3.73	3.56	3.95	37.13	49.78	26.52	11.64	7.24	11.83	16.48	13.42	191.11
1991	7.51	4.54	3.84	7.96	40.67	25.14	16.74	10.24	7.89	25.6	20.66	11.25	182.04
1992	6.52	4.52	4.33	4.73	88.1	90.38	42.18	61.95	43.76	31.54	17.72	10.58	406.32
1993	5.58	3.55	3.63	10.83	25.29	14.25	11.75	12.93	23.52	20.7	14.57	8.4	155
1994	5.25	3.53	3.39	3.64	51.98	30.33	36.61	38.53	26.37	31.31	47.2	29.81	307.94
1995	13.23	7.18	6.54	-	-	-	-	-	-	-	-	-	

Table 20. Monthly and annual surface runoff in the Albany River drainage basin.

(All values in mm)

Surface Runoff	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1984	5.99	3.9	3.22	34.6	61.9	51.8	30	21.34	8.79	11.88	10.21	7.36	250.96
1985	5.42	4	3.83	32.8	83.1	39.8	34.4	42.02	32.25	59.65	45.12	21.15	403.51
1986	9.46	4.6	3.45	21.4	59.1	23.4	19.5	7.81	5.65	19.4	12.66	6.37	192.86
1987	4.04	2.73	2.7	14.9	20.9	17.7	18.7	21.52	16.62	21.18	13	8.96	163.07
1988	4.99	2.89	2.57	21.9	65.7	30.9	22.4	20.05	28.66	33.64	27.8	13.21	274.62
1989	6.56	4.24	3.72	7.14	84.8	35.4	15.3	10.72	6.79	8.31	9.23	5.35	197.47

Table 21. Monthly and annual surface runoff in the Moose River drainage basin.

(All values in mm)

Surface Runoff	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1983	11.27	8.33	12.66	22.69	205.6	90.47	21.43	8.61	22.27	35.85	18.93	13.6	471.7
1984	12.59	9.73	12.23	77.25	75.94	49	57.94	17.33	7.95	13.7	24.78	20.3	378.75
1985	11.53	8.11	10.41	60.27	115.5	34.94	31.25	25.75	10.38	28.42	24.6	16.5	377.7
1986	9.19	7.19	9.47	67.62	87.34	19.15	14.2	15.01	19.17	38.17	22.42	14.1	323.06
1987	12.8	10.02	14.06	46.31	27.55	24.88	24.22	24.62	10.58	25.29	23.56	17.8	261.65
1988	10.05	8.05	8.02	63.16	125.6	25.45	13.56	30.91	21.61	25.7	57.91	30.9	420.94
1989	11.71	10.03	10.96	17.23	157.3	55.58	18.49	11.65	8.07	11.07	29.62	14.1	355.81
1990	10.55	7.11	18.51	63.3	147.9	58.4	40.54	16.75	20.88	50.43	42.43	19.1	495.85
1991	10.56	8.38	9.51	77.89	70	23.44	7.43	5.91	14.2	38.43	28.66	18.8	313.19
1992	9.8	7.4	8.28	30.75	155.4	22.15	20.14	24.37	32.7	41.67	30.71	22.4	405.81
1993	13.47	9.38	9.96	42.55	122	62.61	28.35	33.25	35.91	35.36	25.38	12.6	430.76
1994	7.1	5.63	6.12	26.83	77.07	46.08	43.72	53.14	25.96	21.95	18.11	11.6	343.35
1995	8.85	8.62	14.35	20.39	85.59	41.57	26	7.06	6.07	52.4	34.44	12.6	317.97
1996	7.96	8.2	9.27	11.37	228.8	60.36	24.73	15.91	7.52	18.67	25.33	12.4	430.49

Table 22. Monthly and annual surface runoff in the Montreal River drainage basin.

(All values in mm)

Surface Runoff		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
	1972	17.39	23.12	33.22	24.89	90.65	29.66	22.34	30.65	21.99	21.8	20.93	22.51	359.16
	1973	32.14	27.67	42.64	56.13	79.97	61.59	31.78	22.49	14.77	25.7	27.11	26.78	448.76
	1974	17.32	21.29	36.84	35.45	102.7	51.34	33.56	14.31	13.85	22.8	27.1	23.5	400.09
	1975	25.1	22.23	28.04	36.84	70.49	46.59	17.71	7.63	7.96	7.27	9.91	16.27	296.05
	1976	18.88	19.03	33.09	81.54	89.27	28.95	14.83	12.48	14.9	18	14.86	15.49	361.33
	1977	19.31	18.22	29.98	79.65	58.94	19.07	15.19	10.68	11.79	15.2	22.3	21.96	322.27
	1978	27.91	27.18	25.04	22.48	77.43	33.21	14.9	13.09	14.13	25.5	22.84	20.61	324.31
	1979	21.18	25.16	31.69	73.63	165.3	51.62	31.86	18	14.62	26.2	36.31	44.99	540.59
	1980	33.16	25.46	19.98	44.14	74.71	23.18	18.69	12.96	13.72	23	24.92	26.04	339.97
	1981	20.85	21.51	29.18	90.29	43.71	39.34	24.26	12.61	12.48	19	18.08	22.88	354.17
	1982	26.87	25.25	21.19	25.36	56.78	17.44	10.67	4.56	12.06	26.1	29.8	35.64	291.69
	1983	33.94	29.4	23.05	27.67	104.8	74.18	14.79	16.87	11.09	25	21.81	29.11	411.67
	1984	33.62	28.83	24.34	52.17	50.98	45.62	49.77	24.36	13.26	19.4	30.86	34.04	407.21

Table 23. Monthly and annual surface runoff in the Petawawa River drainage basin.

(All values in mm)

Surface Runoff	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1965	10.85	9.06	10.31	29.9	113.8	27.49	13.44	13.43	14.43	36.12	43.24	42.69	364.74
1966	37.42	23.42	29.06	83.15	82.92	42.86	17.27	9.34	6.33	6.83	20.03	73.25	431.87
1967	32.84	20.79	18.51	91.46	71.6	43.72	27.62	10.36	9.41	32.68	58.5	35.71	453.2
1968	24.33	16.68	21.16	90.28	41.39	22.38	20.81	11.17	12.2	10.44	9.95	15.67	296.47
1969	16.86	13.39	12.9	74.22	107.3	47.65	23.75	12.3	14.9	13.71	32.16	31.17	400.25
1970	16.42	11.66	12.01	49.45	99.74	39.9	35.2	32.18	15.18	20.29	21.8	26.53	380.36
1971	20.57	16.72	19.36	71.76	107.8	34.33	12.69	6.36	5.26	5.89	6.5	15.27	322.46
1972	16.68	13.53	13.3	38	160.1	58.33	48.43	38.31	29.88	33.77	55.8	35.56	541.7
1973	30.83	26.79	46.23	144.8	85.96	59.14	42.43	25.64	12.43	14.84	18.08	29.72	536.91
1974	22.46	19.51	25.22	97.77	140.8	46.91	21.38	11.82	8.65	16.32	26.56	27.09	464.44
1975	18.83	14.6	16.27	44.25	91.38	26.13	10.79	7.96	5.8	10.63	12.36	25.88	284.89
1976	18.17	13.59	27.55	138.2	68.36	31.14	32.89	12.27	7.68	8.65	9.36	11.97	379.81
1977	9.96	7.76	19.39	88.28	46.03	14.86	8.88	5.01	6.58	19.38	26.73	32.82	285.69
1978	21.74	14.88	11.66	48.29	116	32.78	11.19	7.81	11.2	18.98	14.58	16.72	325.82
1979	17.21	14.8	21.17	117.3	102.9	33.53	17.71	16.76	12.48	25.13	38.07	41.48	458.54
1980	25.57	15.28	18.12	107	66.59	38.45	46.33	37.81	26.31	43.58	43.8	33.92	502.8
1981	21.78	28.85	57.89	109.8	63.81	39.39	21.46	17.35	52.63	56.39	31.81	24.76	525.94
1982	19.09	15.48	15.73	67.94	75.86	30.2	16.96	6.67	9.56	14.72	25.18	50.29	347.68
1983	49.62	22.86	31.58	74.5	117.8	46.74	13.24	6.84	8.29	16.44	31.22	32.76	451.84
1984	21.33	22.11	32.96	124.4	87.88	55.31	26.46	13.68	8.87	9.79	22.95	28.75	454.53
1985	30.51	18.23	30.75	112.2	104	24.96	16.88	12.87	13.95	10.65	16.76	24.33	416.09
1986	17.53	12.57	16.68	100.6	58.61	38.8	14.87	12.34	6.11	12.24	12.07	12.91	315.33
1987	11.46	9.77	13.93	79.14	34.48	25.82	10.94	5.4	4.5	6.09	14.17	18.94	234.65
1988	16.56	14.8	14.2	93.34	63.27	17.75	8.14	15.79	14.8	29.11	41.99	30.31	360.05
1989	18.93	13.68	16.16	62.57	80.16	40.47	20.89	6.67	4	4.07	13.98	18.18	299.77
1990	15.04	14.51	36.38	81.38	75.08	30.14	16.85	6.5	3.34	13.31	25.04	46.05	363.63
1991	23.92	15.85	27.67	125.9	52.74	20.91	7.51	6.68	6.38	13.34	26.36	33.33	360.62
1992	23.14	15.7	18.55	58.62	95.5	23.92	20.32	12	22	28.74	58.49	40.83	417.8
1993	28.34	18.83	15.23	72.56	54.19	42.34	21.55	9.3	8.37	28.06	34.73	28.64	362.15
1994	16.22	12.52	12.57	42.11	62.22	36.85	42.72	21.27	11.36	13.37	27.16	29.99	328.37
1995	30.53	24.4	38.46	48.72	62.67	34.64	16.02	14.03	7.8	14.2	45.78	33.94	371.19
1996	24.84	30.13	24	77.08	132.5	43.08	34.67	23.26	15.26	14.87	27.96	30.91	478.59

Table 24. Estimates of monthly and annual groundwater contributions to surface runoff at gauging station 04CA003 in the Severn River drainage basin (1967-1992).

(All flow values in mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total Annual	Percent of Runoff
1967	---	---	---	---	---	---	---	---	---	2.06	2.86	3.55	—---	----
1968	3.36	2.80	2.54	5.13	9.30	11.08	6.50	7.82	5.95	6.91	4.69	2.87	68.95	19.32
1969	2.31	2.47	3.12	4.18	5.12	7.23	9.77	14.73	12.07	7.80	4.21	3.13	76.14	14.85
1970	2.26	1.75	1.79	2.42	9.19	4.08	3.00	2.19	3.17	5.53	5.58	2.89	43.86	18.05
1971	2.21	1.72	1.82	7.73	10.46	3.02	3.20	2.31	1.01	2.23	2.15	1.81	39.67	18.64
1972	1.39	1.03	1.01	3.44	12.76	3.12	1.26	1.12	1.63	3.35	2.09	1.45	33.64	15.78
1973	1.23	0.97	1.07	4.87	11.80	7.22	7.70	2.03	2.40	3.86	3.08	2.09	48.33	16.69
1974	1.31	1.07	1.10	2.46	11.55	14.82	6.95	12.96	10.07	5.79	4.34	3.85	76.26	18.36
1975	3.43	2.88	3.06	5.89	13.52	9.91	6.83	12.88	7.97	4.88	3.87	3.59	78.71	21.24
1976	3.31	2.98	3.08	6.21	8.97	4.74	3.36	2.01	1.52	0.89	1.88	2.45	41.40	31.54
1977	2.74	2.55	2.86	5.91	5.89	2.86	3.46	4.70	4.05	2.82	1.85	1.73	41.44	19.69
1978	1.35	0.98	1.04	2.58	9.35	6.48	7.23	6.76	5.71	3.57	3.81	3.42	52.29	15.33
1979	2.73	1.88	1.44	6.68	11.50	6.43	2.59	1.81	3.33	4.85	4.22	2.91	50.36	16.31
1980	1.62	1.24	1.13	5.25	8.02	1.70	1.26	2.01	3.00	3.08	2.20	1.49	32.00	18.56
1981	2.03	2.76	2.77	4.53	5.22	7.14	4.69	1.29	3.75	5.67	3.80	2.62	46.27	19.66
1982	1.43	1.01	2.69	5.26	11.65	12.59	5.20	7.30	4.42	3.49	2.38	2.04	59.46	14.78
1983	1.48	1.38	2.44	3.26	4.33	5.01	4.68	1.78	1.36	2.18	2.53	2.39	32.82	18.71
1984	1.98	1.67	1.73	6.00	8.59	4.45	3.61	2.00	1.33	1.58	2.04	2.00	36.98	14.79
1985	1.48	1.09	1.42	5.08	9.73	13.71	15.35	8.09	6.69	4.90	3.19	1.79	72.49	16.72
1986	1.80	3.45	3.19	12.30	14.40	4.89	1.83	3.49	3.07	5.01	2.71	1.86	58.01	18.97
1987	1.39	2.32	3.69	7.31	4.74	4.22	1.92	1.16	1.39	1.86	2.06	1.80	33.85	19.72
1988	1.66	2.19	3.12	3.79	4.83	2.18	1.77	1.50	1.93	2.83	1.99	1.81	29.62	19.11
1989	1.49	1.08	1.03	2.18	9.15	6.75	2.92	3.34	3.76	3.13	1.90	1.51	38.24	15.68
1990	2.37	3.87	3.69	10.06	13.98	5.07	1.77	1.34	1.11	1.30	1.39	1.34	47.26	22.15
1991	1.18	0.95	0.99	1.87	2.08	1.63	1.39	1.28	2.25	3.60	3.01	2.36	22.60	13.81
1992	1.64	1.08	1.05	3.83	---	---	---	---	---	---	---	---	----	----
Mean	**1.97**	**1.89**	**2.11**	**5.13**	**9.00**	**6.26**	**4.51**	**4.41**	**3.87**	**3.73**	**2.95**	**2.35**	**48.36**	**17.78**

Table 25. Estimates of monthly and annual groundwater contributions to surface runoff at gauging station 04DA001 in the Winisk River drainage basin (1967-1996).

(All flow values in mm)

Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total Annual**	**Percent of Runoff**
1967	7.90	4.05	3.02	6.46	19.19	14.54	5.05	4.56	2.92	2.81	3.10	4.02	77.62	29.18
1968	5.74	4.51	3.88	7.09	14.95	13.49	10.16	9.29	8.63	8.55	7.91	7.80	102.00	22.02
1969	7.42	6.38	6.52	5.72	5.96	7.93	6.83	5.70	10.26	15.12	12.87	11.48	102.20	20.97
1970	9.63	6.93	5.72	4.86	10.76	8.83	9.69	9.88	9.82	9.94	8.25	6.35	100.66	25.38
1971	5.63	4.52	6.61	11.87	16.38	9.38	8.87	11.05	5.62	7.88	8.53	6.16	102.53	26.37
1972	5.66	5.02	5.07	5.19	14.10	13.29	12.39	11.03	9.38	8.35	6.83	5.92	102.21	30.57
1973	4.98	4.27	4.67	5.01	5.76	6.08	5.87	6.03	7.37	7.47	6.59	6.28	70.38	25.39
1974	5.76	4.75	4.80	5.73	17.69	21.23	17.88	11.69	10.83	8.56	6.18	5.79	120.90	24.44
1975	5.40	4.75	5.14	4.98	6.80	8.36	7.91	7.60	7.71	7.02	6.09	5.98	77.75	26.76
1976	5.60	4.90	4.76	6.70	10.18	6.59	5.22	4.95	5.28	5.33	4.94	4.85	69.30	38.19
1977	4.60	3.80	3.85	5.63	8.55	5.92	5.80	6.82	6.57	5.99	5.05	5.95	68.53	27.67
1978	6.25	4.34	4.15	4.55	10.90	11.60	11.30	10.33	8.86	7.18	6.15	5.74	91.35	22.75
1979	5.15	4.14	4.05	4.53	5.87	6.30	6.10	7.79	8.38	9.04	7.48	6.65	75.48	21.57
1980	5.91	4.85	4.43	4.91	9.56	5.76	3.73	3.70	5.79	6.50	5.84	5.29	66.26	30.89
1981	4.54	3.40	3.17	3.69	5.50	8.21	7.09	4.02	5.50	6.30	5.30	4.94	61.66	27.22
1982	4.40	3.50	3.49	3.45	13.34	10.93	6.86	5.29	5.71	8.44	7.64	6.82	79.88	21.78
1983	5.74	4.25	3.94	3.82	5.77	6.92	11.46	5.10	3.77	4.18	4.46	5.21	64.63	33.26
1984	6.09	5.34	4.06	6.87	8.31	7.03	6.02	4.58	4.14	5.32	5.39	4.71	67.86	28.39
1985	4.21	3.61	3.79	5.61	22.59	11.16	7.46	7.60	8.24	9.73	6.36	7.37	97.72	18.87
1986	7.12	4.93	4.44	10.41	13.38	10.46	8.11	5.66	5.25	5.66	5.70	6.13	87.24	34.37
1987	6.37	5.53	4.81	6.39	6.89	6.03	5.50	4.83	4.60	5.26	4.70	4.40	65.30	31.25
1988	3.85	2.70	2.57	3.59	5.71	4.72	3.96	3.25	3.76	5.19	4.15	3.84	47.30	29.21
1989	3.50	2.87	2.87	3.14	8.88	8.46	5.42	3.74	3.79	3.60	3.26	3.36	52.89	26.46
1990	3.35	3.02	3.24	3.17	3.31	3.19	3.29	3.03	2.97	3.58	3.59	4.27	40.01	22.49
1991	5.01	4.16	3.64	5.40	7.59	5.29	4.99	3.55	3.59	5.45	6.50	9.56	64.74	30.93
1992	8.23	5.62	4.64	5.11	20.95	14.64	7.63	6.96	6.51	4.74	3.82	3.71	92.56	24.25
1993	3.46	2.91	2.99	3.15	4.17	3.58	4.40	5.78	5.85	5.10	4.46	4.26	50.12	26.62
1994	3.89	3.20	3.19	3.01	4.84	4.73	5.35	5.02	4.47	7.48	7.57	6.66	59.43	21.24
1995	5.65	4.24	3.74	3.53	4.76	5.17	4.95	4.53	3.98	4.31	5.50	7.10	57.47	26.40
1996	6.74	4.65	4.00	4.15	12.68	11.19	---	---	---	---	---	---	-----	-----
Mean	**5.59**	**4.37**	**4.18**	**5.26**	**10.18**	**8.70**	**7.22**	**6.32**	**6.19**	**6.69**	**6.01**	**5.88**	**76.41**	**25.71**

Table 26. Estimates of monthly and annual groundwater contributions to surface runoff at gauging station 04DB001 in the Winisk River drainage basin (1968-1994).

(All flow values in mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total Annual	Percent of Runoff
1968	4.69	4.23	4.36	3.72	4.42	4.91	5.29	5.70	5.94	7.15	7.93	8.07	66.39	23.41
1969	7.79	6.80	6.94	5.89	6.75	6.79	6.62	5.82	5.28	5.23	4.84	4.77	73.51	18.37
1970	4.54	3.90	4.10	3.83	7.22	9.52	8.70	6.30	6.04	8.08	7.14	7.90	77.30	19.91
1971	9.21	9.44	11.31	10.03	13.97	9.39	5.38	6.50	5.57	7.13	8.86	9.18	105.97	24.73
1972	9.08	7.57	5.68	5.02	8.44	8.14	6.53	5.94	7.60	9.31	6.57	6.11	85.98	23.85
1973	6.73	6.09	5.12	4.54	8.47	9.44	9.95	6.88	4.64	5.00	5.38	5.54	77.77	21.81
1974	5.65	5.19	5.85	5.43	5.87	5.97	6.28	6.39	6.25	6.08	5.91	6.45	71.32	19.98
1975	6.80	6.43	6.50	4.94	7.94	7.56	6.87	8.82	8.20	6.04	5.08	5.83	81.00	23.63
1976	6.50	6.56	6.53	6.50	9.06	8.23	7.24	5.95	4.88	5.16	5.18	5.55	77.34	30.96
1977	5.75	5.02	4.92	6.04	6.52	5.75	4.63	3.98	4.45	4.84	4.74	5.73	62.36	36.47
1978	6.76	6.96	7.46	7.68	10.31	8.59	7.90	6.67	5.75	5.49	4.96	5.12	83.67	22.60
1979	5.20	4.76	5.35	5.25	6.04	6.01	4.96	5.58	5.35	5.46	5.21	5.05	64.22	24.40
1980	4.69	4.07	4.13	5.19	6.94	5.76	5.25	4.85	5.34	8.24	6.84	6.11	67.42	19.71
1981	5.13	3.85	3.94	3.76	6.11	7.60	6.12	4.44	4.41	6.12	5.87	5.49	62.82	22.45
1982	4.96	4.02	4.51	6.07	9.27	9.08	7.79	6.62	6.01	5.78	5.75	5.65	75.51	17.41
1983	5.20	4.31	4.35	3.78	5.04	6.26	5.38	4.62	4.16	5.15	5.45	5.98	59.68	26.71
1984	6.51	6.57	7.48	6.99	8.33	7.08	5.73	4.60	3.95	4.26	5.19	7.33	73.98	29.73
1985	9.33	9.49	7.92	6.60	16.38	12.63	10.59	7.18	5.57	6.34	6.96	8.04	107.03	20.33
1986	8.90	8.30	7.29	6.75	12.01	8.38	4.98	4.61	6.05	6.91	5.79	6.09	86.07	25.79
1987	6.42	6.08	6.46	6.27	7.44	5.70	5.01	4.55	5.17	5.71	5.36	5.47	69.63	27.02
1988	5.46	5.09	5.43	5.25	5.41	5.23	5.32	4.71	4.37	5.39	5.23	5.11	61.99	26.95
1989	4.81	4.09	4.25	3.82	5.05	6.41	5.70	4.63	4.20	5.13	5.45	5.26	58.80	29.24
1990	4.83	4.00	4.04	3.91	6.27	7.14	5.74	4.23	3.72	3.79	3.67	3.79	55.13	37.24
1991	3.78	3.41	3.78	3.56	4.53	4.79	4.26	4.10	3.90	4.53	5.35	5.52	51.51	31.09
1992	5.05	4.31	4.15	3.63	6.87	9.88	7.56	6.92	7.28	7.80	7.09	6.85	77.39	19.64
1993	6.37	5.34	5.39	4.51	4.51	4.09	4.63	5.00	4.80	5.22	4.99	4.86	59.71	34.87
1994	4.55	3.85	3.98	3.67	4.35	4.88	5.51	5.36	5.19	6.09	---	---	----	----
Means	**6.26**	**5.61**	**5.60**	**5.25**	**7.46**	**7.38**	**6.48**	**5.76**	**5.45**	**6.03**	**5.81**	**5.99**	**73.60**	**24.40**

Table 27. Estimates of monthly and annual groundwater contributions to surface runoff at gauging station 04FA002 in the Attawapiskat River drainage basin (1967-1993).

(All flow values in mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total Annual	Percent of Runoff
1967	---	---	---	---	---	---	---	---	---	---	6.13	6.29	----	----
1968	6.25	5.66	5.97	8.35	19.38	18.81	14.41	11.66	12.73	14.55	10.01	8.32	136.09	25.91
1969	7.75	6.51	6.68	9.70	13.33	17.42	12.27	11.09	12.25	14.77	10.53	9.28	131.58	24.26
1970	8.61	7.20	7.34	6.38	10.90	10.98	12.05	9.51	11.19	10.56	9.88	10.72	115.30	27.04
1971	11.24	9.43	8.94	10.76	11.30	8.78	7.42	6.68	5.92	7.94	7.60	7.41	103.44	27.72
1972	6.93	6.09	6.10	6.52	10.40	7.61	7.92	8.41	9.91	10.97	8.20	7.61	96.67	27.14
1973	7.03	5.84	5.91	6.00	9.11	8.02	11.67	13.32	11.38	9.14	7.50	9.27	104.19	28.22
1974	10.87	8.27	7.92	9.46	20.28	19.01	10.41	10.30	13.02	9.55	7.36	6.86	133.31	25.85
1975	7.34	7.24	7.73	7.64	10.06	10.05	9.92	11.44	8.21	6.55	7.00	6.83	100.01	29.65
1976	6.27	5.49	6.55	8.14	9.44	7.09	6.09	4.89	4.50	4.65	4.29	4.31	71.72	45.31
1977	3.89	2.98	3.19	5.95	8.62	8.39	9.05	6.38	7.64	6.34	4.57	5.80	72.80	22.85
1978	6.88	5.52	4.90	5.65	11.39	10.68	7.05	7.66	6.07	4.94	4.69	4.53	79.97	24.73
1979	4.19	3.49	3.70	6.84	11.23	8.13	8.43	9.49	12.76	9.78	9.34	7.09	94.46	19.80
1980	7.13	5.40	4.43	5.27	6.19	4.08	3.90	3.62	5.13	6.27	4.75	3.76	59.92	32.89
1981	3.48	3.06	3.45	5.45	7.07	5.53	4.12	3.35	3.12	3.33	4.23	5.56	51.73	39.95
1982	5.40	4.56	5.09	6.06	12.82	8.49	6.94	5.05	4.65	5.90	4.69	4.09	73.74	26.37
1983	4.23	3.95	4.52	4.52	4.73	5.18	8.51	3.87	3.44	4.04	4.15	4.89	56.04	33.56
1984	5.63	5.94	6.42	7.01	7.47	7.30	4.53	3.74	3.39	3.91	3.90	5.64	64.87	32.84
1985	7.94	6.44	5.54	8.41	12.17	9.74	8.27	8.01	8.55	9.19	5.46	4.49	94.20	18.53
1986	5.00	5.60	5.51	8.40	9.83	4.90	4.75	3.80	3.53	4.46	4.41	4.88	65.06	33.12
1987	5.20	4.98	5.51	5.78	5.51	5.67	4.29	5.02	4.66	3.81	3.62	3.94	58.00	35.53
1988	4.13	4.03	4.38	4.48	4.81	5.39	6.69	4.94	5.71	6.21	4.85	5.35	60.97	28.15
1989	5.92	5.83	5.98	5.56	8.19	7.21	5.42	4.32	6.60	4.67	4.01	4.49	68.19	30.23
1990	4.94	4.85	5.27	5.34	8.48	9.82	7.17	4.87	3.34	3.85	4.18	4.60	66.69	30.47
1991	4.48	3.95	4.26	4.29	9.11	8.52	6.34	4.21	4.17	5.99	5.54	6.77	67.62	27.02
1992	7.69	6.49	6.34	7.46	12.01	10.08	6.81	6.56	8.83	6.05	4.50	4.52	87.34	22.55
1993	4.38	3.85	4.13	3.87	3.83	3.74	5.48	5.53	---	---	---	---	-----	-----
means	**6.26**	**5.49**	**5.61**	**6.67**	**9.91**	**8.87**	**7.69**	**6.84**	**7.23**	**7.10**	**5.98**	**6.05**	**84.56**	**26.94**

Table 28. Estimates of monthly and annual groundwater contributions to surface runoff at gauging station 04FA003 in the Attawapiskat River drainage basin (1966-1994).

(All flow values in mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total Annual	Percent of Runoff
1966	---	---	---	---	---	---	---	---	---	20.28	14.55	7.98	-----	----
1967	4.34	3.34	3.44	5.63	16.57	16.24	8.65	4.71	3.56	---	---	4.05	-----	----
1968	3.81	3.35	3.14	4.99	9.86	10.50	10.57	9.98	11.67	12.66	8.45	6.43	95.43	22.18
1969	6.89	5.05	5.14	8.68	13.75	10.77	8.42	7.50	11.55	11.45	6.38	7.22	102.82	19.52
1970	8.31	5.70	4.72	5.85	12.53	7.67	7.10	6.92	12.31	15.57	15.99	17.18	119.86	26.54
1971	12.37	7.47	6.36	14.54	18.37	6.78	8.58	13.30	5.73	9.14	11.08	9.78	123.49	24.89
1972	8.00	5.85	4.72	5.85	15.58	12.73	10.10	7.07	6.60	9.60	7.30	8.97	102.37	28.15
1973	9.35	6.07	5.32	8.67	16.39	9.35	11.20	7.23	6.60	7.09	6.55	6.20	100.01	29.14
1974	5.61	4.57	4.26	5.31	17.39	17.01	13.18	16.88	10.84	7.20	5.95	5.71	113.92	21.47
1975	5.27	4.37	4.37	4.68	12.83	8.96	8.35	9.12	5.65	4.62	5.34	5.03	78.60	24.34
1976	4.36	3.44	3.22	6.82	9.76	6.17	4.43	4.48	5.13	5.55	4.21	3.93	61.49	26.10
1977	3.48	2.63	2.66	7.77	9.08	5.14	5.50	5.39	7.97	5.03	4.32	6.50	65.46	23.05
1978	6.61	4.92	4.91	7.07	16.37	9.89	5.65	9.37	9.83	6.27	5.95	6.88	93.73	22.61
1979	5.08	3.38	3.85	7.78	13.54	9.17	9.45	7.60	12.83	9.87	11.96	9.76	104.28	20.56
1980	7.04	4.21	2.99	5.09	8.35	3.74	3.20	3.39	5.16	6.97	6.76	7.30	64.19	28.98
1981	4.85	4.11	5.17	7.67	13.00	9.80	6.27	3.17	2.91	3.09	2.92	2.94	65.91	22.67
1982	2.87	2.52	2.72	3.77	15.66	10.49	6.50	7.10	6.88	7.48	6.92	5.99	78.92	18.71
1983	4.80	3.32	2.76	2.93	6.91	6.23	9.87	4.61	3.37	4.07	4.45	6.12	59.46	27.03
1984	6.41	4.73	4.22	8.99	11.25	7.86	5.44	3.81	3.67	4.90	6.11	9.69	77.08	28.12
1985	8.29	5.02	4.18	6.51	20.60	10.76	9.87	5.05	9.26	10.54	7.80	6.45	104.33	19.53
1986	4.82	2.97	2.34	5.42	12.88	4.18	4.73	3.72	3.67	5.62	4.83	5.96	61.14	22.04
1987	4.41	3.12	3.55	8.05	7.49	3.58	3.47	3.52	4.47	4.13	3.87	4.41	54.08	25.33
1988	4.70	3.63	3.12	3.90	6.00	5.29	3.37	2.65	6.65	11.12	9.23	7.70	67.36	22.71
1989	5.82	3.72	3.18	3.02	7.38	7.45	6.24	5.87	5.76	4.64	3.50	3.35	59.93	30.43
1990	3.16	2.63	1.91	1.82	7.57	6.53	5.94	5.20	4.33	3.74	2.96	3.62	49.41	25.25
1991	4.68	3.73	3.39	5.21	8.16	4.81	2.97	2.06	2.39	5.21	5.29	5.45	53.33	26.89
1992	3.65	2.50	2.36	3.09	6.81	6.80	7.40	7.81	6.02	3.77	2.98	3.12	56.32	14.99
1993	3.17	2.90	2.97	2.85	3.28	2.47	2.50	2.70	3.93	3.35	3.41	3.99	37.52	29.68
1994	3.33	2.32	2.29	2.74	6.68	5.55	10.18	5.91	4.20	6.12	---	---	-----	----
Means	**5.55**	**3.98**	**3.69**	**5.88**	**11.57**	**8.07**	**7.11**	**6.29**	**6.53**	**7.47**	**6.63**	**6.49**	**78.86**	**23.43**

Table 29. Estimates of monthly and annual groundwater contributions to surface runoff at gauging station 04JC003 in the Albany River drainage basin (1952-1986).

(All flow values in mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total Annual	Percent of Runoff
1952	9.31	6.93	6.13	10.71	12.02	9.89	8.77	7.30	5.66	5.08	5.05	5.35	92.20	31.99
1953	5.49	5.07	5.75	9.88	24.51	15.34	7.39	5.14	4.66	5.10	5.10	5.75	99.19	26.28
1954	5.20	4.50	5.94	13.85	17.74	9.46	6.55	5.91	5.26	8.19	8.82	7.80	99.20	25.19
1955	6.47	4.74	4.64	10.19	14.19	7.88	4.64	2.78	2.24	3.73	4.33	4.36	70.19	31.57
1956	4.21	3.80	3.91	4.02	11.38	13.07	7.91	3.47	2.61	2.92	3.07	3.42	63.77	20.33
1957	3.67	3.53	4.15	4.25	4.64	8.24	11.10	6.62	3.70	4.92	5.95	4.49	65.25	20.02
1958	6.28	7.39	7.27	14.33	12.77	11.59	12.77	10.67	7.84	5.18	6.12	7.39	109.60	27.17
1959	7.97	6.87	7.02	8.61	16.30	7.49	3.15	2.72	3.16	4.47	4.28	3.39	75.43	24.61
1960	3.84	5.70	7.00	8.46	20.59	9.66	2.78	2.99	2.40	2.52	3.05	5.67	74.67	20.77
1961	8.23	5.77	5.29	13.73	18.17	7.05	4.64	2.63	4.42	6.51	5.04	4.24	85.72	19.55
1962	3.73	2.93	2.76	4.45	12.39	8.47	3.69	5.67	8.36	3.60	2.82	3.25	62.12	17.21
1963	2.66	1.94	2.49	7.38	11.17	9.08	3.72	2.18	2.34	2.30	2.23	4.72	52.23	18.69
1964	6.38	4.69	4.94	14.30	15.14	9.93	7.07	5.16	5.84	5.05	4.23	5.47	88.20	19.58
1965	7.77	7.31	7.24	11.74	14.70	7.64	2.81	2.19	4.22	6.20	4.12	3.90	79.84	22.74
1966	3.71	3.18	3.34	3.31	3.68	3.81	6.22	6.73	3.76	5.79	6.19	7.74	57.47	12.07
1967	9.15	8.28	9.53	13.49	17.43	14.10	7.54	2.74	1.85	2.67	3.58	3.93	94.30	24.93
1968	4.18	4.13	4.64	4.73	5.19	5.97	8.75	6.35	4.87	6.06	6.15	8.45	69.46	18.44
1969	10.60	10.72	10.23	12.95	13.89	5.03	3.59	2.60	2.25	3.30	3.18	4.59	82.94	27.13
1970	6.79	7.51	7.14	7.20	11.39	5.92	4.16	2.37	3.80	4.89	4.38	5.43	70.99	25.60
1971	6.76	6.56	6.36	7.44	12.62	10.36	3.93	3.04	4.20	4.90	6.25	9.08	81.51	23.06
1972	10.70	9.67	9.01	10.61	12.68	5.32	4.16	3.68	2.73	4.01	3.38	3.35	79.29	25.08
1973	3.24	2.84	3.06	7.34	11.68	5.58	6.55	4.71	3.93	4.17	4.03	5.00	62.12	17.70
1974	7.35	7.73	7.51	8.74	15.32	8.09	3.80	4.92	4.94	7.94	6.64	6.71	89.68	20.96
1975	6.72	6.08	6.74	6.53	6.76	5.97	3.78	2.19	1.86	2.34	3.84	4.51	57.31	21.87
1976	4.77	4.68	5.07	5.33	5.76	5.64	3.82	2.63	1.95	2.19	3.45	6.36	51.65	20.47
1977	6.55	5.72	8.76	18.28	15.05	7.91	5.10	2.80	6.76	6.60	4.95	6.91	95.38	25.16
1978	8.30	5.47	5.19	7.60	17.36	10.59	5.59	2.81	1.93	3.03	2.57	2.50	72.93	23.40
1979	2.37	2.04	2.37	9.15	20.39	9.16	3.50	2.90	5.36	8.08	7.58	6.63	79.53	17.29
1980	9.57	7.22	6.72	12.81	16.07	5.33	3.50	3.07	3.95	4.67	3.84	3.52	80.27	24.43
1981	3.08	2.41	4.64	8.44	10.86	5.29	3.09	1.80	1.60	1.80	2.20	4.47	49.68	20.06
1982	6.39	4.65	4.62	7.75	13.44	4.27	6.16	6.15	5.27	8.16	6.73	7.03	80.63	20.67
1983	9.90	8.98	10.68	13.71	17.71	8.99	3.59	2.08	2.43	6.04	4.62	3.12	91.83	25.04
1984	2.68	2.58	6.40	10.10	9.59	7.53	6.17	3.82	2.20	2.51	3.13	3.45	60.16	17.14
1985	6.45	6.59	6.17	9.32	9.51	4.56	3.64	5.42	5.21	6.10	6.41	8.26	77.64	22.71
1986	8.36	5.18	4.74	13.88	12.67	5.02	2.88	1.99	3.37	6.32	4.99	4.35	73.76	25.05
means	**6.24**	**5.54**	**5.99**	**9.70**	**13.51**	**8.05**	**6.15**	**4.21**	**4.01**	**4.87**	**4.76**	**5.40**	**77.65**	**22.43**

Table 30. Estimates of monthly and annual groundwater contributions to surface runoff at gauging station 04GB004 in the Albany River drainage basin (1971-1996).

(All flow values in mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total Annual	Percent of Runoff
1971	---	---	---	---	---	---	---	---	13.42	14.96	18.08	17.97	-----	----
1972	16.74	14.55	14.31	11.61	13.63	13.03	12.17	11.97	11.54	12.04	11.82	11.89	155.30	58.97
1973	11.50	9.81	9.83	9.13	12.09	11.11	11.55	11.62	10.71	10.59	10.15	10.44	128.54	44.21
1974	10.59	9.69	10.86	10.54	11.14	10.92	11.43	11.60	11.65	11.61	10.81	10.64	131.48	27.54
1975	10.06	8.71	9.42	9.96	13.07	12.40	11.46	10.25	9.37	9.46	9.30	9.49	122.95	46.53
1976	9.31	8.55	8.73	8.95	11.40	10.12	9.66	8.94	7.35	6.29	5.21	4.80	99.31	60.36
1977	4.93	5.11	6.38	6.89	7.81	6.86	7.46	7.65	7.86	7.51	6.37	6.90	81.73	29.65
1978	7.42	7.14	8.39	8.61	9.60	10.65	8.73	7.64	6.86	6.78	6.23	6.17	94.22	28.01
1979	5.92	5.13	5.44	5.48	8.12	7.74	6.90	6.09	6.94	7.13	6.86	6.62	78.35	28.07
1980	6.02	5.26	5.48	6.24	7.47	6.45	5.53	5.14	4.89	5.73	6.13	6.07	70.42	35.78
1981	5.79	4.99	5.30	5.52	6.39	6.59	6.50	5.62	4.95	4.91	4.86	5.52	66.95	39.60
1982	6.03	5.88	6.98	7.10	8.00	7.59	6.84	6.21	5.71	6.25	6.64	6.81	80.05	34.94
1983	6.21	5.31	5.56	5.22	6.13	6.28	6.32	6.19	5.79	5.64	5.46	5.63	69.74	26.52
1984	5.71	6.15	7.62	8.41	9.35	8.91	8.10	6.83	5.68	5.55	5.45	5.98	83.76	29.27
1985	5.96	5.13	5.43	5.83	12.48	10.76	8.60	7.38	7.10	9.48	9.56	9.68	97.38	21.64
1986	9.47	8.37	9.08	8.59	8.67	7.88	6.60	5.74	5.32	5.86	5.71	5.74	87.04	33.27
1987	5.55	4.85	5.19	5.19	5.74	5.53	5.58	5.55	5.16	5.18	5.00	5.15	63.68	42.51
1988	5.13	4.78	5.09	5.05	6.35	7.26	7.44	7.14	10.24	11.53	8.70	8.00	86.70	23.89
1989	7.15	5.72	5.73	7.88	11.57	9.79	7.81	6.41	5.41	5.25	4.98	5.13	82.83	28.82
1990	5.11	4.59	5.04	5.04	7.18	9.19	9.29	7.16	5.62	5.45	5.16	5.34	74.18	26.93
1991	5.32	5.12	6.55	7.23	8.39	8.14	7.60	6.36	5.35	5.61	5.76	5.97	77.41	32.21
1992	5.71	6.08	9.72	11.40	16.20	13.51	9.41	9.29	11.71	10.27	7.57	6.77	117.64	25.83
1993	5.99	5.03	5.34	5.02	5.46	5.55	6.81	8.80	12.15	10.61	8.19	7.05	86.00	24.43
1994	5.89	5.03	5.30	4.95	5.68	6.06	7.05	7.57	7.41	7.42	7.76	7.49	77.61	25.97
1995	6.86	5.66	5.84	5.55	8.34	9.37	8.69	6.83	5.31	5.54	5.82	5.84	79.65	27.36
1996	5.64	5.11	5.35	5.07	9.31	9.93	9.36	7.29	6.29	---	---	---	-----	----
means	**7.20**	**6.47**	**7.12**	**7.22**	**9.18**	**8.87**	**8.28**	**7.65**	**7.68**	**7.86**	**7.50**	**7.48**	**91.37**	**31.69**

Table 31. Estimates of monthly and annual groundwater contributions to surface runoff at gauging station 04LA002 in the Moose River drainage basin (1974-1996).

(All flow values in mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total Annual	Percent of Runoff
1974	12.69	11.87	13.08	13.28	19.10	14.79	12.18	11.69	11.14	11.30	11.50	12.12	154.73	37.57
1975	12.36	11.55	12.51	11.67	15.79	17.10	11.24	8.79	8.03	8.37	8.69	9.95	136.06	41.43
1976	10.87	10.14	10.14	16.87	17.36	9.87	8.83	8.48	7.09	7.76	7.12	7.89	122.41	32.53
1977	8.16	7.08	12.52	18.82	13.41	7.63	7.35	7.10	7.28	7.85	7.63	8.71	113.55	36.70
1978	9.28	8.06	8.70	7.63	12.47	12.49	10.81	8.42	9.55	10.44	8.67	9.03	115.56	29.56
1979	9.60	8.55	10.43	12.70	21.86	13.03	9.54	8.45	8.31	7.70	9.03	10.05	129.24	25.23
1980	10.00	9.08	9.10	9.06	11.35	9.04	8.03	7.76	7.45	7.82	7.54	8.32	104.55	31.69
1981	8.93	8.65	8.98	12.58	11.83	9.79	8.58	7.57	7.48	7.93	8.09	8.67	109.06	30.18
1982	8.41	8.58	8.61	8.47	10.16	8.11	9.98	7.87	7.58	9.86	8.95	8.93	105.50	32.35
1983	8.72	8.05	8.92	9.03	17.53	15.41	8.09	7.28	7.53	8.59	7.89	8.56	115.59	28.02
1984	8.77	8.09	8.48	9.73	8.79	10.66	10.85	8.50	7.79	8.03	8.01	9.27	106.97	30.80
1985	9.45	9.04	9.22	10.36	17.09	11.02	9.57	8.19	8.10	7.92	8.49	9.17	117.62	27.30
1986	9.51	8.45	9.41	10.92	12.80	8.46	8.05	10.34	9.83	11.57	10.30	9.33	118.98	26.13
1987	8.79	8.23	8.22	8.32	7.27	6.71	7.29	7.29	6.56	6.98	6.90	7.56	90.12	39.97
1988	8.13	7.15	8.28	9.80	11.79	8.00	7.01	6.93	7.13	7.24	10.38	10.50	102.33	26.95
1989	9.34	8.74	10.24	8.32	15.27	12.62	8.48	7.26	6.63	6.68	6.95	8.04	108.55	27.23
1990	8.31	8.29	10.12	13.58	14.67	12.44	11.25	7.96	6.62	8.63	10.03	10.46	122.35	23.75
1991	9.07	8.55	8.97	12.17	11.20	7.49	6.82	6.72	5.75	5.86	6.18	7.00	95.78	31.56
1992	7.93	7.65	8.40	8.70	8.96	7.09	6.12	5.52	5.71	7.33	7.27	7.35	88.03	29.45
1993	7.40	7.50	7.57	5.72	10.98	9.56	6.85	6.52	5.77	6.85	6.91	6.92	88.53	24.57
1994	7.70	7.29	6.94	6.38	9.20	7.81	6.16	5.57	6.22	5.85	5.67	5.86	80.65	28.79
1995	6.91	6.94	7.89	6.22	10.17	9.78	5.96	5.69	5.21	5.85	6.17	6.64	83.41	27.22
1996	7.76	8.07	7.94	5.90	20.38	10.82	6.06	6.57	5.71	6.73	6.12	----	-----	-----
Means	**9.20**	**8.63**	**9.80**	**10.83**	**14.43**	**11.60**	**9.41**	**8.55**	**8.10**	**8.60**	**8.69**	**9.21**	**109.52**	**30.40**

Table 32. Estimates of monthly and annual groundwater contributions to surface runoff at gauging station 04LJ001 in the Moose River drainage basin (1920-1996).

(All flow values in mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total Annual	Percent of Runoff
1920	---	---	---	---	113.69	35.81	11.78	6.58	3.28	3.26	3.10	3.07	-----	----
1921	2.12	1.53	1.73	6.04	8.46	7.46	3.80	3.27	2.62	3.60	3.33	6.49	50.46	24.82
1922	5.06	3.54	3.54	16.71	25.14	6.59	3.18	2.03	1.71	1.63	1.61	1.61	72.35	29.52
1923	1.54	1.34	1.38	3.12	6.51	3.93	3.94	3.11	6.00	9.71	6.49	5.73	52.79	26.34
1924	6.29	4.60	4.07	6.58	10.70	6.15	3.15	3.76	3.27	3.61	3.76	4.41	60.36	25.81
1925	4.11	3.13	3.33	6.48	11.22	10.37	5.70	3.98	2.57	2.99	2.97	2.42	59.25	20.26
1926	2.15	1.72	1.50	2.14	10.83	8.33	11.42	7.68	4.76	4.95	7.45	11.52	74.45	23.88
1927	9.33	4.67	6.17	19.41	16.11	7.74	8.68	4.06	3.45	7.04	5.10	5.54	97.30	22.45
1928	6.55	5.52	5.81	9.18	10.47	11.87	9.87	9.09	9.15	11.93	7.84	7.94	105.23	16.30
1929	8.47	4.75	4.52	11.31	14.93	8.31	4.11	5.85	8.06	5.44	7.71	11.00	94.46	24.17
1930	6.66	4.12	4.17	17.08	24.50	9.35	5.16	3.82	2.41	3.46	2.80	2.69	86.22	23.98
1931	2.39	1.90	1.81	6.43	16.47	5.79	3.34	1.79	2.12	4.67	8.96	12.43	68.09	24.37
1932	12.71	8.97	8.06	13.20	17.31	6.58	3.78	3.88	4.06	4.09	5.63	8.94	97.20	27.27
1933	8.39	5.14	4.31	15.53	19.73	8.60	4.02	2.11	1.81	2.80	5.22	5.54	83.21	24.75
1934	4.31	2.92	2.89	7.07	21.12	8.01	3.93	2.34	5.73	4.24	5.63	8.27	76.46	19.88
1935	9.25	5.47	4.76	14.60	20.63	12.92	5.22	3.88	4.77	8.53	9.69	9.79	109.52	24.05
1936	5.42	3.90	3.54	6.77	8.66	9.27	5.46	1.96	2.12	3.41	4.64	6.44	61.57	16.25
1937	4.49	3.79	4.42	14.92	23.19	9.03	7.63	4.33	2.15	3.13	3.96	3.90	84.93	25.95
1938	4.42	4.18	4.81	12.39	20.81	16.20	7.75	3.97	2.56	2.32	2.40	2.75	84.55	18.85
1939	4.57	5.88	5.32	12.89	31.04	9.82	4.73	4.35	4.13	3.74	3.08	4.65	94.22	21.49
1940	6.29	4.57	3.53	6.92	23.48	14.91	4.25	2.60	2.97	3.89	5.27	7.00	85.67	22.45
1941	6.86	4.87	4.18	11.18	21.27	4.89	2.92	3.15	10.68	8.83	5.32	6.86	91.00	19.43
1942	10.44	6.10	5.45	20.19	15.88	4.41	2.95	2.90	7.27	12.96	7.09	6.29	101.92	23.95
1943	8.19	5.66	5.05	15.77	19.14	13.53	6.16	2.64	2.06	1.47	2.04	1.96	83.65	24.13
1944	1.67	1.30	2.37	8.30	23.02	8.05	4.21	2.14	3.93	3.40	2.91	4.70	66.01	19.83
1945	5.62	4.29	7.32	18.10	14.19	5.26	3.38	2.50	2.13	2.46	5.92	4.62	75.79	22.19
1946	2.73	4.29	6.86	9.50	20.63	20.23	7.89	1.63	2.17	2.82	4.65	5.82	89.23	22.87
1947	8.74	5.26	4.74	9.63	36.96	20.60	5.50	3.78	2.22	2.01	2.79	3.94	106.16	22.73
1948	3.18	2.66	2.87	17.04	10.24	4.14	2.18	2.96	2.20	1.99	3.64	3.81	56.89	20.50
1949	2.85	5.54	5.10	15.44	16.26	6.95	3.14	1.67	1.63	3.44	2.87	2.43	67.33	21.27
1950	2.22	1.83	1.83	5.52	27.81	16.69	7.29	2.06	1.36	2.43	3.06	3.09	75.20	17.60
1951	2.37	1.53	4.90	16.11	16.89	4.77	3.51	1.94	2.06	4.58	6.04	5.10	69.80	16.58
1952	3.93	2.63	2.19	14.66	13.97	10.30	3.61	2.28	1.63	1.60	2.28	7.24	66.30	20.34
1953	7.10	5.14	7.39	24.15	27.66	7.16	2.87	1.49	1.38	1.91	2.12	3.98	92.34	24.76
1954	2.34	1.22	1.61	14.14	20.06	5.58	4.14	2.33	2.36	7.07	4.93	6.11	71.90	17.27
1955	5.23	3.65	3.58	15.82	12.76	4.67	1.99	1.31	1.18	3.58	3.37	6.90	64.04	25.43

1956	8.22	5.53	4.52	12.47	24.72	14.71	8.41	3.03	4.35	3.13	3.28	7.48	99.86	26.42
1957	5.89	3.95	4.18	16.05	20.34	5.37	4.42	1.82	3.47	2.86	4.55	4.18	77.08	22.38
1958	2.98	1.67	2.84	11.80	7.61	10.66	5.51	3.04	7.56	5.15	6.45	10.61	75.89	20.77
1959	7.67	4.51	4.64	14.30	19.67	4.49	2.01	2.47	4.18	8.49	10.50	8.11	91.05	25.30
1960	5.33	2.53	5.05	11.19	30.22	9.96	2.47	3.34	2.10	1.68	2.71	3.46	80.05	18.02
1961	2.52	1.47	2.96	11.49	20.56	10.77	7.59	2.53	9.83	9.84	5.35	4.35	89.28	17.74
1962	3.04	1.66	4.38	9.96	17.95	8.41	2.37	4.86	8.96	4.77	2.41	3.56	72.35	19.29
1963	4.67	4.17	3.72	7.31	15.36	12.07	5.36	1.97	2.11	1.85	1.39	1.38	61.36	20.70
1964	1.33	1.24	1.29	10.23	18.57	9.21	6.28	6.23	3.98	7.61	6.35	6.16	78.49	16.44
1965	4.15	2.02	3.49	9.20	19.56	5.79	2.23	3.88	5.63	6.85	3.83	5.74	72.37	18.70
1966	7.77	6.48	7.28	11.67	19.65	6.85	3.42	3.32	3.77	10.01	5.82	8.07	94.12	21.05
1967	8.41	7.14	6.18	16.37	19.47	6.70	3.32	2.33	1.27	2.71	3.61	6.14	83.65	22.24
1968	4.92	3.55	4.06	22.58	14.99	7.70	12.75	4.43	7.43	7.76	7.00	9.94	107.11	21.14
1969	11.53	8.08	6.33	15.12	16.01	4.68	2.92	1.91	2.41	4.00	3.87	7.45	84.31	22.73
1970	6.04	3.19	3.02	7.51	15.27	7.25	5.85	2.83	2.50	2.44	3.67	5.90	65.48	20.75
1971	7.28	4.74	3.99	7.61	17.97	8.81	4.25	2.52	2.92	3.74	5.30	5.72	74.84	20.26
1972	8.61	5.41	4.71	6.70	20.23	9.89	5.49	3.58	3.49	3.98	2.80	3.01	77.91	22.54
1973	3.28	3.19	3.78	13.61	19.30	7.14	6.71	6.03	5.24	4.74	3.87	6.13	83.02	19.13
1974	7.79	5.24	4.83	6.20	18.79	7.33	3.81	3.31	3.95	5.81	6.31	9.05	82.41	21.52
1975	7.36	4.73	4.01	7.28	13.00	6.26	2.22	1.54	1.44	2.04	3.18	3.38	56.45	26.27
1976	3.15	2.74	2.71	15.80	13.51	4.31	2.62	2.05	1.33	1.44	1.41	1.38	52.47	21.25
1977	1.16	0.83	1.85	16.76	10.60	6.64	2.87	1.88	3.98	7.62	7.24	9.57	71.00	19.75
1978	6.50	3.90	2.56	4.37	23.03	7.49	9.76	2.89	3.35	12.01	10.11	8.01	93.96	24.63
1979	5.36	3.50	2.64	13.69	30.70	9.53	4.41	2.11	4.34	13.53	7.78	3.72	101.31	17.54
1980	5.93	5.49	4.05	13.09	14.61	6.53	3.93	1.88	2.46	3.67	4.56	5.99	72.18	25.04
1981	4.64	4.24	8.08	11.44	18.25	5.46	2.37	1.30	1.43	1.74	2.93	4.51	66.39	21.96
1982	3.47	2.53	2.44	8.79	21.11	7.76	9.32	3.46	7.41	10.51	7.84	7.76	92.39	22.21
1983	10.05	7.35	9.14	19.01	28.03	8.98	3.02	1.63	2.36	6.30	8.94	10.49	115.31	27.05
1984	7.18	4.97	5.06	13.18	12.14	10.20	10.45	2.49	2.11	2.17	2.89	2.91	75.74	22.30
1985	6.34	3.98	3.68	12.77	14.65	5.25	5.29	4.29	3.09	5.50	3.56	2.74	71.15	21.56
1986	2.27	1.64	1.85	12.22	10.98	2.64	2.20	1.54	2.27	4.10	3.60	5.67	50.98	18.65
1987	5.76	3.61	3.58	11.11	7.93	3.27	5.76	4.19	1.63	2.70	4.30	6.49	60.33	25.46
1988	6.22	3.78	3.57	11.35	12.82	3.95	2.79	5.11	2.69	3.78	7.86	8.65	72.58	20.11
1989	10.16	6.38	4.56	14.65	23.10	8.61	3.15	2.07	1.60	2.43	5.35	5.06	87.12	23.26
1990	4.56	3.69	3.58	19.46	19.18	8.22	5.19	2.29	4.01	5.15	6.45	6.41	88.18	19.69
1991	7.45	4.79	4.13	13.97	10.00	3.31	1.74	1.37	2.86	7.40	5.57	2.75	65.33	20.34
1992	1.94	4.21	4.45	10.50	25.30	7.78	2.94	3.86	5.27	6.44	4.15	3.15	80.00	17.98
1993	2.74	2.17	2.07	8.78	15.09	8.23	6.06	8.60	6.50	5.30	7.68	7.65	80.88	18.72
1994	4.82	3.18	2.86	7.03	11.24	6.85	4.17	4.24	2.20	2.09	1.85	1.63	52.17	17.84
1995	1.53	2.31	3.74	8.02	9.94	6.11	3.94	2.04	1.58	9.47	12.21	8.20	69.08	22.15
1996	3.71	1.87	3.56	5.03	28.40	11.16	3.44	2.49	1.48	2.48	3.63	---	-----	----
means	**5.42**	**3.88**	**4.09**	**11.89**	**19.24**	**8.58**	**4.88**	**3.19**	**3.57**	**4.86**	**4.91**	**5.76**	**78.69**	**21.43**

Table 33. Estimates of monthly and annual groundwater contributions to surface runoff at gauging station 02JD004 in the Upper Ottawa River drainage basin (1938-1957).

(All flow values in mm)

Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total Annual**	**Percent of Runoff**
1938	14.89	13.45	14.86	24.85	23.23	15.70	13.81	13.16	12.32	12.19	12.16	12.61	183.22	46.29
1939	12.53	11.29	12.06	13.04	23.89	17.84	16.23	12.54	10.96	12.39	11.71	11.80	166.27	42.68
1940	11.50	10.19	9.76	10.45	16.75	16.12	13.24	10.04	9.54	9.95	9.54	9.89	136.98	40.91
1941	11.53	12.39	12.16	18.85	16.29	11.61	13.49	12.55	13.31	18.38	17.10	15.63	173.31	30.85
1942	13.22	9.86	10.68	17.15	15.48	11.38	10.50	9.83	9.08	9.40	9.52	9.76	135.84	44.89
1943	9.59	8.65	10.92	12.35	15.80	13.44	12.60	11.27	9.67	9.59	9.22	9.48	132.59	46.63
1944	9.42	9.00	10.12	10.28	11.13	11.16	10.45	9.93	9.86	10.45	10.14	9.81	121.76	47.46
1945	10.96	9.88	13.12	15.87	14.32	12.42	10.91	9.85	9.43	10.37	10.86	10.04	138.04	35.79
1946	10.21	10.89	13.94	13.40	16.19	15.45	11.75	9.88	9.50	9.67	9.90	12.04	142.82	47.23
1947	10.32	8.71	10.21	13.22	24.05	21.77	12.78	10.42	9.54	9.53	8.38	5.58	144.51	31.78
1948	5.63	5.16	5.64	8.96	12.25	7.86	6.93	6.63	5.90	5.60	5.47	6.38	82.42	33.30
1949	6.14	5.62	6.44	11.30	13.58	9.96	8.98	7.04	6.07	6.10	5.77	5.83	92.84	27.15
1950	5.69	5.85	9.76	13.52	18.47	10.85	7.94	6.24	5.91	6.01	5.72	5.89	101.84	32.55
1951	5.89	5.41	7.94	18.77	13.71	9.40	8.28	7.05	6.97	7.43	7.40	7.85	106.10	20.47
1952	7.74	7.05	7.34	6.91	6.94	6.52	6.52	6.51	6.52	6.96	6.95	8.39	84.34	27.56
1953	10.41	11.14	14.26	14.89	12.66	9.19	7.58	7.51	7.22	7.41	7.13	7.31	116.70	33.72
1954	7.26	6.52	7.31	9.43	14.41	10.88	8.11	6.65	6.63	12.91	9.78	7.41	107.30	23.46
1955	6.41	5.48	5.85	8.12	10.33	7.65	6.37	5.88	4.85	5.52	6.53	7.89	80.87	31.30
1956	9.02	9.33	10.76	11.92	13.43	13.11	12.09	10.59	8.82	8.03	7.43	7.35	121.87	33.49
1957	7.02	6.05	6.38	---	---	---	---	---	---	---	---	---	----	----
means	**9.27**	**8.60**	**9.98**	**13.33**	**15.42**	**12.23**	**10.45**	**9.13**	**8.53**	**10.16**	**9.80**	**9.56**	**124.72**	**34.74**

Table 34. Estimates of monthly and annual groundwater contributions to surface runoff at gauging station 02JD008 in the Upper Ottawa River drainage basin (1931-1971).

(All flow values in mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total Annual	Percent of Runoff
1931	15.34	13.30	14.72	17.95	19.93	16.15	12.60	11.17	9.46	9.61	10.62	11.06	161.90	46.18
1932	9.72	8.94	9.87	12.72	14.12	9.71	9.20	9.68	10.52	12.92	13.59	10.80	131.80	31.79
1933	9.48	8.61	9.84	14.86	16.08	11.60	9.75	9.51	8.69	9.05	9.10	9.28	125.86	34.39
1934	9.42	8.50	9.34	10.30	20.38	11.10	9.32	9.46	9.07	9.54	10.05	10.59	127.08	34.31
1935	9.75	8.35	9.90	11.47	13.07	10.34	10.27	9.31	9.00	9.30	8.83	9.33	118.93	40.24
1936	9.30	8.57	9.45	11.05	23.02	12.05	9.33	9.40	8.85	9.29	9.04	9.39	128.74	33.07
1937	9.48	8.54	9.34	11.16	13.91	9.70	9.62	10.67	10.07	10.42	11.41	11.18	125.51	34.75
1938	9.53	8.41	11.42	19.37	15.46	11.33	9.47	9.41	9.13	9.23	8.92	9.18	130.86	31.46
1939	9.26	8.39	9.36	10.43	18.40	14.43	11.27	9.19	8.84	9.43	9.26	9.31	127.57	34.20
1940	9.28	8.67	9.19	9.36	13.99	14.10	11.58	9.57	9.54	9.54	9.97	10.31	125.10	36.10
1941	9.45	8.79	10.06	16.48	15.63	10.34	11.80	10.60	11.20	15.62	14.49	13.65	148.10	26.93
1942	11.01	8.68	10.21	14.35	12.99	10.70	9.50	9.39	8.98	9.19	8.91	9.13	123.05	36.10
1943	9.08	8.09	9.18	10.50	13.97	11.92	10.97	9.33	9.04	9.30	9.13	9.44	-----	----
1944	9.29	8.71	9.30	10.36	13.20	9.89	9.43	9.32	9.09	9.28	9.11	9.34	116.33	41.70
1945	---	---	---	13.43	15.79	18.99	9.95	9.09	8.88	9.48	9.75	9.68	105.03	29.22
1946	10.09	8.87	11.65	11.17	11.77	11.49	10.13	9.27	9.04	9.47	9.06	10.30	122.33	36.36
1947	10.38	9.31	10.66	12.47	24.07	24.28	11.62	9.08	8.75	9.17	9.39	8.80	147.98	26.20
1948	8.42	8.05	8.59	11.28	13.41	9.66	9.45	9.38	9.10	9.55	9.43	9.71	116.02	42.79
1949	9.35	8.77	11.65	13.92	16.26	13.20	13.66	9.57	9.12	8.98	8.59	8.91	131.98	31.29
1950	8.87	8.35	9.60	9.97	15.66	11.88	10.12	8.98	8.56	8.69	8.41	9.08	118.16	36.53
1951	9.34	8.90	10.01	17.56	14.70	11.19	11.08	9.94	10.04	15.31	14.76	12.44	145.25	24.43
1952	9.88	9.49	10.08	13.19	14.95	11.13	9.43	9.31	8.90	9.31	8.91	9.44	124.01	33.26
1953	9.70	8.92	11.50	16.90	15.73	9.98	9.74	9.25	8.47	8.44	8.45	8.89	125.97	31.49
1954	9.09	8.97	11.80	14.47	16.18	14.99	10.89	9.41	9.22	12.14	12.78	11.06	141.01	25.44
1955	10.29	9.20	9.62	13.10	11.83	9.23	8.88	8.78	8.46	9.41	11.31	10.28	120.39	36.31
1956	10.18	9.44	9.54	9.82	17.93	12.55	10.34	9.86	10.02	11.02	9.35	9.76	129.82	29.93
1957	9.84	9.10	9.93	9.48	10.53	9.98	17.52	9.27	9.87	9.56	10.40	10.47	125.96	27.95
1958	10.19	9.10	9.77	9.90	10.21	9.61	9.47	8.77	8.72	9.92	9.84	9.98	115.48	38.58
1959	9.70	8.64	9.15	9.84	14.40	9.77	9.08	7.06	7.15	8.40	8.98	8.74	110.90	33.55
1960	8.40	7.99	8.04	10.94	29.34	13.00	11.06	7.97	8.33	7.94	8.21	8.38	129.62	21.28
1961	7.98	7.40	8.12	8.26	12.29	10.70	9.41	7.87	9.94	8.82	8.29	8.71	107.79	27.40
means	**8.04**	**7.36**	**8.37**	**10.85**	**14.15**	**10.44**	**8.80**	**7.71**	**7.56**	**8.29**	**8.36**	**8.35**	**126.95**	**31.96**

Table 35. Monthly and annual hydrologic budget for the Severn River drainage basin.

Meorological Station Name: Big Trout Lake
Station Number: 6010738
Streamflow Station Name: Severn River at Limestone Rapids
Station Number: 04CC001

(All values in mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1954													
Precipitation	13.8	28.6	21.7	39.3	58.6	76.3	62	60.5	69.2	29.5	46.7	26.1	532.3
Rain	0	0	0	21.6	30.6	76.3	62	60.5	69.2	20.7	0	0	340.9
Snow	13.8	28.6	21.7	17.7	28	0	0	0	0	8.8	46.7	26.1	191.4
Snow Melt and Rain	0	0	0	38.85	181	76.3	62	60.5	69.2	20.7	4.2	0	512.9
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	22.1	103.9	131	104	55.55	21.3	0	0	438.37
Actual Evapotranspiration	0	0	0	0	22.1	103.9	106	67.24	55.55	20.8	0	0	376.1
1955													
Precipitation	15.4	24.5	24.5	18.4	48.3	86.1	137	169.6	98.3	58.5	58.1	11.3	750.4
Rain	0	0	0	13.1	46.5	86.1	137	169.6	98.3	48.8	5.6	0	605.4
Snow	15.4	24.5	24.5	5.3	1.8	0	0	0	0	9.7	52.5	11.3	145
Snow Melt and Rain	0	0	0.9	159.3	48.3	86.1	137	169.6	98.3	51.8	8.98	0	760.71
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	13.3	55.1	115.4	128	113.9	50.96	18.5	0	0	495.5
Actual Evapotranspiration	0	0	0	13.3	55.1	114.7	128	113.9	50.96	18.5	0	0	494.72
1956													
Precipitation	14.2	7.9	9.9	9.1	42.1	19.8	52.4	75.3	62.2	59.8	49.9	21	423.6
Rain	0	0	0	1.5	27.1	19.8	52.4	75.3	62.2	36.7	7.1	0	282.1
Snow	14.2	7.9	9.9	7.6	15	0	0	0	0	23.1	42.8	21	141.5
Snow Melt and Rain	0	0	0	12.62	138	19.8	52.4	75.3	62.2	36.7	30.2	0	426.89
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	0	107	121	106.6	42.78	23.8	0	0	401.62
Actual Evapotranspiration	0	0	0	0	0	107	62.5	79.72	42.78	23.8	0	0	315.82
1957													
Precipitation	19.2	12.1	19.3	16.5	43.4	99.1	68.4	98.5	28.6	44.1	35.5	40.7	525.4
Rain	0	0	0	13.4	41.4	99.1	68.4	98.5	28.6	29.6	1	0	380
Snow	19.2	12.1	19.3	3.1	2	0	0	0	0	14.5	34.5	40.7	145.4
Snow Melt and Rain	0	0	0	130.9	43.4	99.1	68.4	98.5	28.6	40.8	2.81	0	512.53
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	

Potential Evapotranspiration	0	0	0	0	34.1	86.52	133	102.4	63.7	27.1	0	0	446.3
Actual Evapotranspiration	0	0	0	0	34.1	86.52	133	99.12	34.18	27.1	0	0	413.55
1958													
Precipitation	23.8	14.9	15.7	36.6	34.6	55.8	76.8	56.1	73.9	30.5	40.3	20.7	479.7
Rain	0	0	0	8.9	25.9	55.8	76.8	56.1	73.9	27.2	1.1	0	325.7
Snow	23.8	14.9	15.7	27.7	8.7	0	0	0	0	3.3	39.2	20.7	154
Snow Melt and Rain	0	0	0	78.06	124	55.8	76.8	56.1	73.9	30.5	1.1	0	496.47
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	23.4	81.31	124	97.08	65.68	21.8	0	0	412.81
Actual Evapotranspiration	0	0	0	0	23.4	81.32	109	62.77	65.68	21.8	0	0	364.36
1959													
Precipitation	14.5	12.5	18.8	20.8	82	70.9	122	90.6	106.9	50.8	45.3	24.4	659.7
Rain	0	0	0	1.5	55.9	70.9	122	90.6	105.1	12.3	0	0	458.5
Snow	14.5	12.5	18.8	19.3	26.1	0	0	0	1.8	38.5	45.3	24.4	201.2
Snow Melt and Rain	0	0	0	7.53	201	70.9	122	90.6	105.1	25.2	0	0	622.54
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	32.6	91.21	129	105.1	63.71	0	0	0	421.34
Actual Evapotranspiration	0	0	0	0	32.6	91.21	128	100.6	63.71	0	0	0	415.79
1960													
Precipitation	15.3	9.1	7.6	12.8	39.2	32	69.4	71.4	49.3	55.8	29.3	11.3	402.5
Rain	0	0	0	4.8	34.9	32	69.4	71.4	49.3	32.6	0	0	294.4
Snow	15.3	9.1	7.6	8	4.3	0	0	0	0	23.2	29.3	11.3	108.1
Snow Melt and Rain	0	0	0	31.58	149	32	69.4	71.4	49.3	42.5	0	0	445.67
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	55.2	103.4	119	109.3	59.9	11.1	0	0	458.02
Actual Evapotranspiration	0	0	0	0	55.2	103.4	77.1	77.14	50.87	11.1	0	0	374.79
1961													
Precipitation	17.6	10.9	17.2	12.2	13.2	13.5	66.2	41.8	89.1	95.3	24.6	41.7	443.3
Rain	0	0	0	4.3	11.7	13.5	66.2	41.8	89.1	64.2	0	0	290.8
Snow	17.6	10.9	17.2	7.9	1.5	0	0	0	0	31.1	24.6	41.7	152.5
Snow Melt and Rain	0	0	7.5	64.53	53	13.5	66.2	41.8	89.1	70	0	0	405.59
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	40.5	96.1	135	107.6	54.68	10.8	0	0	444.2
Actual Evapotranspiration	0	0	0	0	40.5	96.11	76.4	51.24	54.68	10.8	0	0	329.72
1962													
Precipitation	6.3	10.7	7.4	24.9	58.9	46.2	96.8	20.7	54.7	63.3	36.1	22.9	448.9
Rain	0	0	0	0	54.3	46.2	96.8	20.7	54.7	58.9	0	0	331.6

Snow	6.3	10.7	7.4	24.9	4.6	0	0	0	0	4.4	36.1	22.9	117.3
Snow Melt and Rain	0	0	0	29.4	168	49	96.8	20.7	54.7	62.5	7.5	0	488.2
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	38.5	111.5	120	101.3	58.8	25.7	0	0	455.41
Actual Evapotranspiration	0	0	0	0	38.5	111.6	100	33.46	55.32	25.7	0	0	365
1963													
Precipitation	21	14.4	41.5	47.9	43.2	50.8	57.5	40	51.2	38.7	63.1	12.1	481.4
Rain	0	0	0	12.7	20.8	50.8	57.5	40	51.2	38.7	15	0	286.7
Snow	21	14.4	41.5	35.2	22.4	0	0	0	0	0	48.1	12.1	194.7
Snow Melt and Rain	0	0	1.8	77.3	141	50.8	57.5	40	51.2	38.7	17.8	0	476.3
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	23.1	98.37	134	102.3	51.28	45.9	0	0	454.69
Actual Evapotranspiration	0	0	0	0	23.1	98.38	70.4	50.06	51.21	39.8	0	0	332.94
1964													
Precipitation	35.3	23	28	49.2	76.6	55	84.9	85.9	63.2	53.4	45.1	31.8	631.4
Rain	0	0	0	9.5	68.7	55	84.9	85.9	59.1	31.5	7.4	0	402
Snow	35.3	23	28	39.7	7.9	0	0	0	4.1	21.9	37.7	31.8	229.4
Snow Melt and Rain	0	0	0	163	107	55	84.9	85.9	63.2	53.4	7.7	0	619.6
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	57.5	93.22	131	92.38	55.7	13.3	0	0	442.8
Actual Evapotranspiration	0	0	0	0	57.5	93.23	101	86.97	55.7	13.3	0	0	407.75
1965													
Precipitation	47.6	48	17.8	21.5	105	84.5	109	74.5	63.3	71	42.2	33.8	717.4
Rain	0	0	0	3.9	78.6	84.5	109	74.5	51.9	61.7	0	0	463.8
Snow	47.6	48	17.8	17.6	25.9	0	0	0	11.4	9.3	42.2	33.8	253.6
Snow Melt and Rain	0	0	0	81.43	227	84.5	109	74.5	63.3	69.5	0	0	709.1
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	51	103.6	110	97.27	50.7	18.6	0	0	431.03
Actual Evapotranspiration	0	0	0	0	51	103.6	110	93.7	50.7	18.6	0	0	427.32
1966													
Precipitation	33.1	20.2	35.1	35.5	29	111.8	112	100.6	77.5	68.9	15.5	33.2	672.4
Rain	0	0	0	0.3	20.3	111.8	112	100.6	77.2	38.7	0	0	460.9
Snow	33.1	20.2	35.1	35.2	8.7	0	0	0	0.3	30.2	15.5	33.2	211.5
Snow Melt and Rain	0	0	0	55.81	175	111.8	112	100.6	77.5	59.8	0	0	692.1
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	33.2	99.09	128	101.6	66.37	0	0	0	428.8
Actual Evapotranspiration	0	0	0	0	33.2	99.09	128	101.6	66.37	0	0	0	428.74

1967													
Precipitation	30.4	14.1	44.3	67.3	34.5	28.9	58.7	65.4	39.7	50.1	31.8	42.9	508.1
Rain	0	0	0	7.1	17.5	28.9	58.7	65.4	39.7	38.2	0	0	255.5
Snow	30.4	14.1	44.3	60.2	17	0	0	0	0	11.9	31.8	42.9	252.6
Snow Melt and Rain	0	0	0	13.28	235	28.9	58.7	65.4	39.7	49.9	0	0	491.03
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	8.71	98.36	120	104.9	77.37	9.64	0	0	418.59
Actual Evapotranspiration	0	0	0	0	8.71	98.38	68.2	71.38	45.27	9.64	0	0	301.6
1968													
Precipitation	28.6	25.9	11.8	8.2	37.9	50.4	116	97.5	53.1	69.1	20.6	8.8	527.5
Rain	0	0	2.9	7.1	37.9	50.4	116	97.5	53.1	63.9	0	0	428.4
Snow	28.6	25.9	8.9	1.1	0	0	0	0	0	5.2	20.6	8.8	99.1
Snow Melt and Rain	0	0	36.9	112.5	37.9	50.4	116	97.5	53.1	69.1	0	0	572.97
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	59.5	95.8	108	90.09	80.51	19.5	0	0	453.38
Actual Evapotranspiration	0	0	0	0	59.5	86.81	108	90.09	59.25	19.5	0	0	423.13
1969													
Precipitation	66	4.9	24.6	8.7	50.1	48.5	62	73.3	136.1	39.2	58.3	32.1	603.8
Rain	0	0	0	1.8	40.4	48.5	62	73.3	136.1	27.2	1	0	390.3
Snow	66	4.9	24.6	6.9	9.7	0	0	0	0	12	57.3	32.1	213.5
Snow Melt and Rain	0	0	0	133.6	50.1	48.5	62	73.3	136.1	35.6	4.89	0	544.1
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	33.3	73.35	130	119.3	44.66	0	0	0	400.87
Actual Evapotranspiration	0	0	0	0	33.3	73.35	111	80.39	44.66	0	0	0	342.52
1970													
Precipitation	23.5	18.2	20.9	47.5	48	94	108	85.6	88.3	58.4	36.4	42.7	671
Rain	0	0	0	7.6	47	94	108	85.6	88.3	18	2.8	0	450.8
Snow	23.5	18.2	20.9	39.9	1	0	0	0	0	40.4	33.6	42.7	220.2
Snow Melt and Rain	0	0	7.5	70.1	170	94	108	85.6	88.3	58.4	3.9	0	684.9
Surface Runoff	7.08	4.3	3.75	3.22	23	61.89	43.7	27.09	21.43	34.4	20.2	11.7	261.83
Potential Evapotranspiration	0	0	0	0	21	104.4	131	109.3	57.79	23.4	0	0	446.95
Actual Evapotranspiration	0	0	0	0	21	104.4	130	97.34	57.79	23.4	0	0	433.99
1971													
Precipitation	22.9	42.9	7.6	59.9	40.6	39.5	96	42.7	46.5	130	46.3	58.4	633.4
Rain	0	0	0	15.9	10.6	39.5	96	42.7	46.5	76	0	0	327.2
Snow	22.9	42.9	7.6	44	30	0	0	0	0	54.1	46.3	58.4	306.2
Snow Melt and Rain	0	0	0	110.7	138	39.5	96	42.7	46.5	90.5	0	0	564.3
Surface Runoff	7.86	5.56	5.17	4.98	36.9	30.48	29.7	30.17	16.62	17.1	14.7	11.1	210.31

Potential Evapotranspiration	0	0	0	0	45.9	106.5	110	103.1	64.41	25.1	0	0	455.4
Actual Evapotranspiration	0	0	0	0	45.9	106.5	98.3	52.16	49.21	25.1	0	0	377.14
1972													
Precipitation	14.4	7.9	6.6	6.3	37.6	49.5	54.9	52.6	108.4	35.2	25.3	28.3	427
Rain	0	0	0	3.6	34.5	46.5	54.9	52.6	107.1	5.6	0	0	304.8
Snow	14.4	7.9	6.6	2.7	3.1	3	0	0	1.3	29.6	25.3	28.3	122.2
Snow Melt and Rain	0	0	15.3	129.4	72.5	49.5	54.9	52.6	108.4	17.1	0	0	499.62
Surface Runoff	8.48	6.47	6.06	5.59	50	34.72	19.7	13.4	14.55	20.1	14.3	11	204.38
Potential Evapotranspiration	0	0	0	0	60.1	108.2	114	107.4	44.37	0	0	0	434.29
Actual Evapotranspiration	0	0	0	0	60.1	108.2	64.6	61.21	44.37	0	0	0	338.37
1973													
Precipitation	26.6	36.1	46.5	82.9	11.7	96.8	69.2	70.5	130.2	61	87.5	25	744
Rain	0	0	0.3	6.9	7.4	96.8	69.2	70.5	130.2	38.3	0	0	419.6
Snow	26.6	36.1	46.2	76	4.3	0	0	0	0	22.7	87.5	25	324.4
Snow Melt and Rain	0	0	8.4	37.12	230	96.8	69.2	70.5	130.2	60.5	0	0	702.68
Surface Runoff	8.34	6.05	5.76	5.37	50.4	35.39	36.7	19.88	20.15	29.8	25.1	18.4	261.33
Potential Evapotranspiration	0	0	0	0	42.6	90.63	121	123.5	55.68	25.3	0	0	458.48
Actual Evapotranspiration	0	0	0	0	42.6	90.63	121	79.32	55.68	25.3	0	0	414.32
1974													
Precipitation	12.7	17	32.1	6.4	46	120.3	60.5	138.1	62.1	11.7	54.8	27.7	589.4
Rain	0	0	0	2.3	43.7	120.3	60.5	138.1	53.4	2.8	0	0	421.1
Snow	12.7	17	32.1	4.1	2.3	0	0	0	8.7	8.9	54.8	27.7	168.3
Snow Melt and Rain	0	0	0	74.81	152	120.3	60.5	138.1	54.2	17.8	9	0	627.1
Surface Runoff	13.31	9.19	8.06	7.13	31.1	60.24	30.8	26.96	29.65	27.5	17.8	13.2	274.94
Potential Evapotranspiration	0	0	0	0	29.7	94.05	136	102.4	37.18	0	0	0	398.86
Actual Evapotranspiration	0	0	0	0	29.7	94.05	136	102.4	37.18	0	0	0	398.87
1975													
Precipitation	39.4	23.7	23	4.4	57.8	64.1	194	130.5	39.7	57.5	20.8	32	687.2
Rain	0	0	0	0.3	46.4	64.1	194	130.5	39.7	13.8	0.8	0	489.9
Snow	39.4	23.7	23	4.1	11.4	0	0	0	0	43.7	20	32	197.3
Snow Melt and Rain	0	0	8.4	92.11	123	64.1	194	130.5	39.7	19.7	47.3	0	719.2
Surface Runoff	10.1	7.33	6.76	10.31	56.9	44.53	37.5	52.47	38.68	37.7	27.2	18.9	348.39
Potential Evapotranspiration	0	0	0	0	56.9	110.6	126	101.8	51.28	18.2	0	0	464.62
Actual Evapotranspiration	0	0	0	0	56.9	110.6	126	101.8	51.28	18.2	0	0	464.63
1976													
Precipitation	31.1	24.1	13.5	53.2	29	87.4	93.6	65	22.9	16.3	42.4	36	514.5
Rain	0	0	4.3	10.7	12.5	87.4	93.6	65	20.9	3.9	0	0	298.3

Snow	31.1	24.1	9.2	42.5	16.5	0	0	0	2	12.4	42.4	36	216.2
Snow Melt and Rain	0	0	7.05	121.5	65.7	87.4	93.6	65	22.9	16.3	0	0	479.4
Surface Runoff	-	-	-	-	-	24.24	19.9	16.54	15.52	10.7	5.92	4.49	97.25
Potential Evapotranspiration	0	0	0	0	47.9	106.2	125	106.8	59.55	5.46	0	0	450.93
Actual Evapotranspiration	0	0	0	0	47.9	106.2	121	72.08	28.96	5.46	0	0	381.76
1977													
Precipitation	36.1	29.3	26.2	29.3	26.8	30.8	122	118.7	45.1	47.2	56	17.9	585.2
Rain	0	0	0.8	12.1	25.6	30.8	122	118.7	45.1	47.2	3.4	0	405.5
Snow	36.1	29.3	25.4	17.2	1.2	0	0	0	0	0	52.6	17.9	179.7
Snow Melt and Rain	0	0	1.1	198.2	26.8	30.8	122	118.7	45.1	47.2	3.4	0	593.1
Surface Runoff	3.7	2.92	2.9	7.63	24.1	11.98	12	23.21	25.78	18.5	15.5	10.8	158.99
Potential Evapotranspiration	0	0	0	0	81.8	100	119	88.56	58.17	31.1	0	0	478.83
Actual Evapotranspiration	0	0	0	0	81.8	42.19	119	88.56	51.32	31.1	0	0	414.17
1978													
Precipitation	10.5	16	39.4	37	13.8	84.4	112	88.7	64.7	70.1	28.8	16.7	582.3
Rain	0	0	0	2	13.8	84.4	112	88.7	64.7	41.6	0.6	0	408
Snow	10.5	16	39.4	35	0	0	0	0	0	28.5	28.2	16.7	174.3
Snow Melt and Rain	0	0	0	48.5	139	84.4	112	88.7	64.7	70.1	7.81	0	615.11
Surface Runoff	7.26	5.01	4.63	4.2	21.8	21.25	27.2	33.37	27.99	23	17.5	13.5	206.65
Potential Evapotranspiration	0	0	0	0	66.5	84.6	123	95.51	53.59	10.2	0	0	433.08
Actual Evapotranspiration	0	0	0	0	66.5	84.6	123	95.22	53.59	10.2	0	0	432.78
1979													
Precipitation	11.2	13.9	26.4	21.9	63.5	35.7	101	82.3	64.7	61	65.2	22.7	569
Rain	0	0	10	13	43.1	35.7	101	82.3	64.7	37.4	3.9	0	390.6
Snow	11.2	13.9	16.4	8.9	20.4	0	0	0	0	23.6	61.3	22.7	178.4
Snow Melt and Rain	0	0	28.5	79.4	66.7	35.7	101	82.3	64.7	45.5	4.2	0	507.49
Surface Runoff	10.73	7.26	6.14	6.52	39.8	36.05	26.9	19.39	17.28	20.5	18.8	12.5	221.82
Potential Evapotranspiration	0	0	0	0	42.4	101.3	133	96.29	48.72	0	0	0	421.8
Actual Evapotranspiration	0	0	0	0	42.4	101.3	106	84.48	48.72	0	0	0	382.57
1980													
Precipitation	34	9.6	22.6	7.7	21.9	63.5	74.2	80	155.7	60.7	18.5	36.9	585.3
Rain	0	0	0.2	2.2	20.2	63.5	74.2	80	134	2.2	0.7	0	377.2
Snow	34	9.6	22.4	5.5	1.7	0	0	0	21.7	58.5	17.8	36.9	208.1
Snow Melt and Rain	0	0	2.9	170.2	21.9	63.5	74.2	80	136.9	27.7	2.2	0	579.5
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	70.8	88.05	126	109.2	43.65	0	0	0	437.33
Actual Evapotranspiration	0	0	0	0	70.8	67.62	82.7	84.7	43.65	0	0	0	349.52

1981													
Precipitation	10	22.2	22.9	13.6	23.9	86.5	82.3	97.2	150.9	35.5	45.3	21.5	611.8
Rain	0	0	1.8	1.4	22.3	86.5	82.3	97.2	150.9	27.9	0.7	0	471
Snow	10	22.2	21.1	12.2	1.6	0	0	0	0	7.6	44.6	21.5	140.8
Snow Melt and Rain	0	4.2	9.32	27.84	156	86.5	82.3	97.2	150.9	35.5	9.8	0	659.8
Surface Runoff	8.13	5.88	5.42	4.61	11.3	30.46	16.1	-	1.14	-	-	-	83.08
Potential Evapotranspiration	0	0	0	0	43.5	91.82	135	113.9	53.98	11.5	0	0	449.82
Actual Evapotranspiration	0	0	0	0	43.5	91.82	134	99.93	53.98	11.5	0	0	434.71
1982													
Precipitation	23.9	20.6	47.5	37.2	35.6	107.3	139	124.8	33.2	57.5	29.3	61.3	717.2
Rain	0	0	2.8	0.4	34.4	93.7	139	124.8	33.2	50.1	8.7	14.8	501.9
Snow	23.9	20.6	44.7	36.8	1.2	13.6	0	0	0	7.4	20.6	46.5	215.3
Snow Melt and Rain	0	0	10.1	83.21	129	107.3	139	124.8	33.2	57.5	9.63	16.7	709.94
Surface Runoff	-	-	-	-	-	47.19	41.1	37.32	25.68	28	20	13.2	212.48
Potential Evapotranspiration	0	0	0	0	71	79.03	125	96.5	61.86	20.2	0	0	453.86
Actual Evapotranspiration	0	0	0	0	71	79.03	125	96.5	61.87	20.2	0	0	453.86
1983													
Precipitation	26.6	19	27.7	14.6	39.7	117.4	76.8	112.6	83.3	47.6	89.8	17.8	672.9
Rain	0	0	0	0.8	15.6	117.4	76.8	112.6	83.3	45.2	10.8	0	462.5
Snow	26.6	19	27.7	13.8	24.1	0	0	0	0	2.4	79	17.8	210.4
Snow Melt and Rain	0	0	0	44.34	148	117.4	76.8	112.6	83.3	47.6	12	0	641.56
Surface Runoff	9.24	6.23	5.66	5.15	15.8	43.95	37.6	24.92	24.1	23	18.2	10.8	224.58
Potential Evapotranspiration	0	0	0	0	11	97.76	135	120.4	62.49	20.9	0	0	447.71
Actual Evapotranspiration	0	0	0	0	11	97.76	135	113.9	62.49	20.9	0	0	441.17
1984													
Precipitation	20.6	25.6	4.7	23	22.7	135.5	90.3	85.8	75.8	62.8	95.1	35.2	677.1
Rain	0	0	0	22.8	21.7	135.5	90.3	85.8	69.3	25	0	0	450.4
Snow	20.6	25.6	4.7	0.2	1	0	0	0	6.5	37.8	95.1	35.2	226.7
Snow Melt and Rain	0	0	0	169.3	22.9	135.5	90.3	85.8	75.8	29.6	0	0	609.16
Surface Runoff	7.89	6.33	4.98	5.02	20.7	25.86	21.2	16.05	16.73	16.2	14.9	11.4	167.22
Potential Evapotranspiration	0	0	0	21.36	44.2	100.5	126	119.8	44.05	21.6	0	0	477.21
Actual Evapotranspiration	0	0	0	21.36	44.2	100.5	126	100.6	44.05	21.6	0	0	457.95
1985													
Precipitation	21.5	14.8	25.2	40.5	50.2	153	78	55	126.1	37.3	24	29	654.6
Rain	0	0	1.6	31.6	50.2	153	78	55	126.1	7.4	5.8	0	508.7
Snow	21.5	14.8	23.6	8.9	0	0	0	0	0	29.9	18.2	29	145.9
Snow Melt and Rain	0	0	5.5	202.8	107	153	78	55	126.1	37.3	5.8	0	770.94
Surface Runoff	8.6	6.04	5.61	6.03	43.4	69.63	60.3	29.88	26.29	34.9	23	15.6	329.45

Potential Evapotranspiration	0	0	0	0	53.6	91.27	118	102.9	59.6	18.2	0	0	443.54
Actual Evapotranspiration	0	0	0	0	53.6	91.27	118	69.55	59.6	18.2	0	0	410.22
1986													
Precipitation	19.9	16.7	60.4	96.4	31.1	73.6	90.3	64.6	142.4	60.8	57.8	25.8	739.8
Rain	0	0	2	42.6	25.7	73.6	90.3	64.6	142.4	33.5	0	0	474.7
Snow	19.9	16.7	58.4	53.8	5.4	0	0	0	0	27.3	57.8	25.8	265.1
Snow Melt and Rain	0	0	4.41	138.2	129	73.6	90.3	64.6	142.4	42.6	0	0	685.2
Surface Runoff	10.56	7.16	6.68	6.55	50.7	30.32	19.9	17.53	24.41	23.7	16	10.4	223.94
Potential Evapotranspiration	0	0	0	0	71.9	91.73	121	102.7	47.3	9.16	0	0	444.04
Actual Evapotranspiration	0	0	0	0	71.9	91.74	118	71.06	47.3	9.16	0	0	409.19
1987													
Precipitation	25.1	26.6	21.6	30.7	33.5	82.8	51.3	141.2	52.9	83.2	34.9	31.6	615.4
Rain	0	0	5.8	28.9	32.5	82.8	51.3	141.2	52.9	53.4	5.4	1	455.2
Snow	25.1	26.6	15.8	1.8	1	0	0	0	0	29.8	29.5	30.6	160.2
Snow Melt and Rain	0	0	61.1	144.2	34	82.8	51.3	141.2	52.9	68.6	11.8	5.51	653.42
Surface Runoff	8.28	6.56	6.59	22.1	28.2	17.31	22.3	19.04	29.91	16.1	13.5	8.29	198.21
Potential Evapotranspiration	0	0	0	11.96	62.5	108.5	122	96.9	67.63	2.15	0	0	471.66
Actual Evapotranspiration	0	0	0	11.96	62.5	98.68	64.6	96.9	66.85	2.15	0	0	403.62
1988													
Precipitation	29.3	18.4	54.2	24.2	48.9	34.8	115	21.2	104.6	32.1	64.4	25.8	573.1
Rain	0	0	0	3.2	48.3	34.8	115	21.2	104.6	13.3	0.2	0	340.8
Snow	29.3	18.4	54.2	21	0.6	0	0	0	0	18.8	64.2	25.8	232.3
Snow Melt and Rain	0	0	0	159.2	79.6	34.8	115	21.2	104.6	18.7	1.4	0	534.69
Surface Runoff	5.89	4.66	4.76	4.88	44	22.97	14.1	11.07	10.21	13.3	9.64	7.03	152.51
Potential Evapotranspiration	0	0	0	0	54.2	107.8	130	111.7	58.83	0	0	0	462.88
Actual Evapotranspiration	0	0	0	0	54.2	107.8	118	35.07	58.83	0	0	0	373.49
1989													
Precipitation	29.5	20.8	20	7.8	70.8	33.2	41.8	74.4	83.2	41.6	41.6	19.2	483.9
Rain	0	0	0	0	63.2	33.2	41.8	74.4	83.2	18.2	0	0	314
Snow	29.5	20.8	20	7.8	7.6	0	0	0	0	23.4	41.6	19.2	169.9
Snow Melt and Rain	0	0	0	45.6	206	33.2	41.8	74.4	83.2	41.2	0	0	524.9
Surface Runoff	5.09	3.61	3.37	3.12	32.7	24.83	15.6	10.53	16.38	23.9	16.1	8.58	163.76
Potential Evapotranspiration	0	0	0	0	56.3	93.28	138	102.8	58.4	17	0	0	465.8
Actual Evapotranspiration	0	0	0	0	56.3	93.29	57.4	78.75	58.4	17	0	0	361.12
1990													
Precipitation	31.8	19.4	42.1	56.6	3.6	43.6	74.4	141.4	35.2	45.4	58.5	26.4	578.4
Rain	0	0.6	0	15.3	2.6	43.6	74.4	141.4	35.2	23.6	20.4	0	357.1

Snow	31.8	18.8	42.1	41.3	1	0	0	0	0	21.8	38.1	26.4	221.3
Snow Melt and Rain	0	24.36	25.2	85.32	79.8	43.6	74.4	141.4	35.2	40.6	39.4	0	589.26
Surface Runoff	5.23	3.98	4.4	4.3	29.8	33.62	21	13.26	10.63	12.3	10.6	9.48	158.46
Potential Evapotranspiration	0	0	0	0	47.6	95.57	129	113.5	50.57	3.46	0	0	440.04
Actual Evapotranspiration	0	0	0	0	47.6	95.58	83.5	113.5	42.73	3.46	0	0	386.39
1991													
Precipitation	17.8	8.8	24.6	31.2	47.2	44.6	106	52.8	108.5	62.2	66	10.2	579.5
Rain	0	0	0	29.2	41.8	44.6	106	52.8	108.5	15.4	3.8	0	401.7
Snow	17.8	8.8	24.6	2	5.4	0	0	0	0	46.8	62.2	10.2	177.8
Snow Melt and Rain	0	2.1	0	130.6	47.2	44.6	106	52.8	108.5	19	18	0	528.49
Surface Runoff	6.7	3.86	3.13	2.67	18.8	13.18	16.2	12.74	11.6	18.6	11.2	8.49	127.18
Potential Evapotranspiration	0	0	0	2.24	61.9	115.1	127	114.3	50.46	0	0	0	470.79
Actual Evapotranspiration	0	0	0	2.24	61.9	111	109	61.92	50.46	0	0	0	396.26
1992													
Precipitation	19.8	19.7	19.4	22.8	75.8	49.8	78.2	91.4	89	9.8	-	-	475.7
Rain	0.4	0	1	0	52.4	49.8	78.2	91.4	88.2	9.8	-	-	371.2
Snow	19.4	19.7	18.4	22.8	23.4	0	0	0	0.8	0	-	-	104.5
Snow Melt and Rain	1.3	0	2.2	53.7	202	49.8	78.2	91.4	89	9.8	-	-	577.05
Surface Runoff	6.94	5.77	5.79	5.58	32.7	44.5	26.5	31.03	26.74	21.7	13.9	9.09	230.18
Potential Evapotranspiration	-	-	-	-	-	-	-	-	-	-	-	-	
Actual Evapotranspiration	-	-	-	-	-	-	-	-	-	-	-	-	

Table 36. Monthly and annual hydrologic budget for the Winisk River drainage basin.

Metorological Station Name: Winisk
Metoeorological Station Number: 6019548
Streamflow Station Name: Winisk River below Asheweig River Tributary
Streamflow Station Number: 04DC001

(All values in mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1969													
Precipitation	28.4	9.1	-	4.6	45.4	20.2	46.8	80.9	56.2	36.2	65.6	13.2	406.6
Rain	0	0	-	0	2	20.2	46.8	80.9	56.2	19.5	18.8	0	244.4
Snow	28.4	9.1	-	4.6	43.4	0	0	0	0	16.7	46.8	13.2	162.2
Snow Melt and Rain	0	0	-	22.5	57.51	82.88	46.8	80.9	56.2	23.74	32.06	0	402.59
Surface Runoff	13.55	8.97	7.08	6.74	46.75	43.07	52.1	35.12	42.96	79.23	42.55	24.02	402.13
Potential Evapotranspiration	-	-	-	-	-	-	-	-	-	-	-	-	
Actual Evapotranspiration	-	-	-	-	-	-	-	-	-	-	-	-	
1970													
Precipitation	12.7	4.6	4.6	29.2	36	98.1	55.7	84.4	56.8	48.5	22.9	17.9	471.4
Rain	0	0	0	0	14.4	89.5	55.7	84.4	56.8	48.5	3.8	0	353.1
Snow	12.7	4.6	4.6	29.2	21.6	8.6	0	0	0	0	19.1	17.9	118.3
Snow Melt and Rain	0	0	0	1.8	96.72	145.88	55.7	84.4	56.8	48.5	3.8	0	493.6
Surface Runoff	14.38	8.28	6.59	5.96	41.79	54.22	37.59	37.49	41.36	65.23	44.42	22.98	380.29
Potential Evapotranspiration	0	0	0	0	0	73.26	117.1	100.7	60.17	33.16	0	0	384.45
Actual Evapotranspiration	0	0	0	0	0	73.26	117.1	87.09	57.35	33.16	0	0	368
1971													
Precipitation	16.8	37.5	10.2	38.2	22.9	63.7	-	-	2.6	-	-	-	191.9
Rain	0	0	0	12.8	21.6	63.7	-	-	2.6	-	-	-	100.7
Snow	16.8	37.5	10.2	25.4	1.3	0	-	-	0	-	-	-	91.2
Snow Melt and Rain	0	0	0	37.53	125.07	63.7	-	-	2.6	-	-	-	228.9
Surface Runoff	14.5	8.95	7.22	6.58	76.15	53.95	30.31	42.66	29.17	45.93	29.25	15.93	360.59
Potential Evapotranspiration	-	-	-	-	-	-	-	-	-	-	-	-	
Actual Evapotranspiration	-	-	-	-	-	-	-	-	-	-	-	-	

Table 37. Monthly and annual hydrologic budget for the Attawapiskat River drainage basin.

Meteorologic Station Name: Lansdowne House
Meteorologic Station Number: 6014350
Streamflow Station Name: Attawapiskat River below Muketei River
Streamflow Station Number: 04FC001

(All values in mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1947													
Precipitation	48.1	58.9	19.9	25.7	57	40.1	131.4	135.7	82.2	26.7	43.8	28	697.5
Rain	0	0	0	2.6	48.1	40.1	131.4	135.7	82.2	26.7	30	0	496.8
Snow	48.1	58.9	19.9	23.1	8.9	0	0	0	0	0	13.8	28	200.7
Snow Melt and Rain	0	0	0	31.19	264.5	40.59	131.4	135.7	82.2	26.7	30	0	742.29
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	12.99	97.75	135.2	117	57.94	45.69	0	0	466.64
Actual Evapotranspiration	0	0	0	0	12.99	97.76	132.1	117	57.94	44.78	0	0	462.56
1948													
Precipitation	15.4	25.7	10.7	24.9	28.7	81.3	181.8	88.7	57.7	29.3	65.2	56.7	666.1
Rain	0	0	0	14.7	22.6	81.3	181.8	88.7	57.7	28.2	48	0	523
Snow	15.4	25.7	10.7	10.2	6.1	0	0	0	0	1.1	17.2	56.7	143.1
Snow Melt and Rain	0	0	10.8	107.7	28.7	81.3	181.8	88.7	57.7	29.3	48	0	634
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	45.58	100.3	127.9	112.6	81.64	32.07	0	0	500.07
Actual Evapotranspiration	0	0	0	0	45.59	99.25	127.9	112.6	78.43	30.45	0	0	494.22
1949													
Precipitation	44.7	22	13.5	21.4	55.9	58.9	67	115.8	59.9	58	41.4	68.9	627.4
Rain	0	0	0	6.6	54.9	58.9	67	115.8	59.9	45.3	2.1	0	410.5
Snow	44.7	22	13.5	14.8	1	0	0	0	0	12.7	39.3	68.9	216.9
Snow Melt and Rain	0	0	0	151.4	80.01	58.9	67	115.8	59.9	57	7.23	0	597.23
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	50.83	115.1	123.6	106.6	50.23	16.61	0	0	463.03
Actual Evapotranspiration	0	0	0	0	50.83	115.1	76.62	106.6	50.23	16.61	0	0	416.04
1950													
Precipitation	32.5	21.3	11.8	63.3	45.7	129.7	80.6	52.5	16.2	70.7	27.3	34.2	585.8
Rain	0	0	0	2.8	36.2	129.7	80.6	52.5	16.2	65.8	0	0	383.8
Snow	32.5	21.3	11.8	60.5	9.5	0	0	0	0	4.9	27.3	34.2	202
Snow Melt and Rain	0	0	0	19.64	259	129.7	80.6	52.5	16.2	70.7	0	0	628.37
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	

Potential Evapotranspiration	0	0	0	0	45.3	86.99	123.9	100.2	66.75	20.23	0	0	443.37
Actual Evapotranspiration	0	0	0	0	45.3	86.99	123.9	73.7	24.6	20.23	0	0	374.7
1951													
Precipitation	16.9	14.8	29	38.1	37.9	57.9	123.9	69.8	61.3	73.1	16.9	30.8	570.4
Rain	0	0	0	4.8	34.8	57.9	123.9	69.8	61.3	26.3	0	2	380.8
Snow	16.9	14.8	29	33.3	3.1	0	0	0	0	46.8	16.9	28.8	189.6
Snow Melt and Rain	0	3.3	7.5	109.9	77.54	57.9	123.9	69.8	61.3	27.1	0	14.02	552.22
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	71.59	108.5	121.8	103.4	55.6	9.1	0	0	470.02
Actual Evapotranspiration	0	0	0	0	71.59	108.5	121.8	80.92	55.6	9.1	0	0	447.51
1952													
Precipitation	47.3	22.5	22.6	29.5	55.6	130.4	107.3	86.4	61	99.3	35.2	19.4	716.5
Rain	0	0	0	13.5	55.6	130.4	107.3	86.4	61	40.1	2	1.5	497.8
Snow	47.3	22.5	22.6	16	0	0	0	0	0	59.2	33.2	17.9	218.7
Snow Melt and Rain	0	0	0	201.6	55.6	130.4	107.3	86.4	61	76.4	21.23	4.22	744.13
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	13.27	65.33	101.7	126.3	109.9	60.19	0	0	0	476.68
Actual Evapotranspiration	0	0	0	13.27	65.33	101.7	126.3	108.4	60.19	0	0	0	475.24
1953													
Precipitation	25.5	29.2	24.6	16.5	40.5	74.1	87	19	32.6	34.8	34.5	35.4	453.7
Rain	0	0	7.1	0.3	27.5	74.1	87	19	32.6	18.8	0.5	0	266.9
Snow	25.5	29.2	17.5	16.2	13	0	0	0	0	16	34	35.4	186.8
Snow Melt and Rain	0	0	27.61	27	133.7	74.1	87	19	32.6	20.8	26.02	0	447.87
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	40.59	99.98	124.9	120.7	53.5	31.76	0	0	471.38
Actual Evapotranspiration	0	0	0	0	40.59	99.98	118.2	36.24	35.98	22.56	0	0	353.52
1954													
Precipitation	15.3	33.3	25.3	69.6	66.7	89.8	65.9	67	90	59.3	12	11.2	605.4
Rain	0	0.3	0	3.6	20.7	89.8	65.9	67	90	29.3	0	0	366.6
Snow	15.3	33	25.3	66	46	0	0	0	0	30	12	11.2	238.8
Snow Melt and Rain	0	15.32	0	47.24	205.5	89.8	65.9	67	90	29.8	0.9	0	611.48
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	25.73	111.1	130.8	107.1	57.3	23.18	0	0	455.26
Actual Evapotranspiration	0	0	0	0	25.73	111.1	125.8	73.37	57.3	23.18	0	0	416.49
1955													
Precipitation	16.8	22.8	49.4	9.4	80.4	84.7	70.2	86.7	111.1	57.6	55.6	12.7	657.4
Rain	0	0	0	7.1	80.4	84.7	70.2	86.7	111.1	40.1	1	0	481.3
Snow	16.8	22.8	49.4	2.3	0	0	0	0	0	17.5	54.6	12.7	176.1

Snow Melt and Rain	0	0	15.3	134.9	80.4	84.7	70.2	86.7	111.1	44.95	6.12	0	634.37
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	14.17	59.96	126.3	135.7	115.6	49.75	20.46	0	0	521.99
Actual Evapotranspiration	0	0	0	14.17	59.96	126.3	101.7	91.4	49.75	20.46	0	0	463.75
1956													
Precipitation	23.1	27.2	5.7	26.4	58.3	21.6	65.8	82.7	46	45.3	53.3	17.3	472.7
Rain	0	0	0	0	51.9	21.6	65.8	82.7	46	45.3	19.6	0	332.9
Snow	23.1	27.2	5.7	26.4	6.4	0	0	0	0	0	33.7	17.3	139.8
Snow Melt and Rain	0	0	0	9.3	206.2	21.6	65.8	82.7	46	45.3	19.6	0	496.53
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	10.58	112.6	122.1	105.1	46.31	32.44	0	0	429.21
Actual Evapotranspiration	0	0	0	0	10.58	112.7	74.49	86.08	46.05	32.44	0	0	362.29
1957													
Precipitation	10.2	30.2	41	21.4	19.9	107.7	72.5	66.9	40.7	26.5	75.5	52.5	565
Rain	0	0	0	15.3	14.1	107.7	72.5	66.9	40.7	21.9	0.8	0	339.9
Snow	10.2	30.2	41	6.1	5.8	0	0	0	0	4.6	74.7	52.5	225.1
Snow Melt and Rain	0	0	0	153.8	19.9	107.7	72.5	66.9	40.7	26.5	6.2	0	494.2
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	47.21	95.07	134.8	102.8	64.62	28.97	0	0	473.45
Actual Evapotranspiration	0	0	0	0	47.21	95.07	131.9	72.71	44.51	26.89	0	0	418.26
1958													
Precipitation	38	46.5	31.5	99.5	45.1	48.7	63.7	91.1	145.2	56.4	42.2	40.4	748.3
Rain	0	0	0	10.2	29.7	48.7	63.7	91.1	145.2	36.3	0.8	0	425.7
Snow	38	46.5	31.5	89.3	15.4	0	0	0	0	20.1	41.4	40.4	322.6
Snow Melt and Rain	0	0	0	153.6	228.8	48.7	63.7	91.1	145.2	56.4	5.91	0	793.41
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	35.94	90.83	126.4	99.23	65.26	23.82	0	0	441.47
Actual Evapotranspiration	0	0	0	0	35.94	90.84	93.09	92.43	65.26	23.82	0	0	401.39
1959													
Precipitation	17.1	16.3	31	45	143.7	123.9	112.2	127	115.7	125.8	59.3	22.6	939.6
Rain	0	0	0.3	5.1	139.1	123.9	112.2	127	115.7	37.9	0	0	661.2
Snow	17.1	16.3	30.7	39.9	4.6	0	0	0	0	87.9	59.3	22.6	278.4
Snow Melt and Rain	0	0	17.7	43.65	268.4	123.9	112.2	127	115.7	49.95	0	0	858.54
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	41.25	101.3	133.3	107.9	67.73	0	0	0	451.47
Actual Evapotranspiration	0	0	0	0	41.25	101.3	133.3	107.9	67.73	0	0	0	451.47
1960													
Precipitation	35.2	15.4	13.3	52.4	51	59.7	52	31.2	52.2	64.8	65.3	41.9	534.4

Rain	0	0	0	17.5	49.7	59.7	52	31.2	52.2	46.7	22.1	0	331.1
Snow	35.2	15.4	13.3	34.9	1.3	0	0	0	0	18.1	43.2	41.9	203.3
Snow Melt and Rain	0	0	0	66.2	258.9	59.7	52	31.2	52.2	64.8	22.1	0	607.05
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	62.68	108.5	122.1	113.4	61.31	16.72	0	0	484.74
Actual Evapotranspiration	0	0	0	0	62.68	108.5	74.78	44.61	53.63	16.72	0	0	360.88
1961													
Precipitation	19.4	44.5	84.4	50.7	28.3	28.8	44.4	45.9	63.9	61	30.8	56.1	558.2
Rain	0	0	0	9	28	28.8	44.4	45.9	63.9	13.4	0	0	233.4
Snow	19.4	44.5	84.4	41.7	0.3	0	0	0	0	47.6	30.8	56.1	324.8
Snow Melt and Rain	0	0	6	77.1	229.3	28.8	44.4	45.9	63.9	19.8	2.7	0	517.9
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	45.32	100.2	136.5	112.4	59.61	16.55	0	0	470.54
Actual Evapotranspiration	0	0	0	0	45.32	100.2	59.42	56.3	59.61	16.55	0	0	337.41
1962													
Precipitation	15.4	16.6	10.8	41.2	53.7	16.4	55.9	92.2	61.6	31.7	66.8	57	519.3
Rain	0	0	0.8	0.8	53.4	16.4	55.9	92.2	61.6	24.5	3.6	1.8	311
Snow	15.4	16.6	10	40.4	0.3	0	0	0	0	7.2	63.2	55.2	208.3
Snow Melt and Rain	0	0	6.52	18.52	238.1	16.4	55.9	92.2	61.6	30.6	25.3	16.24	561.33
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	52.99	114.8	125.2	102.1	55.72	29.09	0	0	479.86
Actual Evapotranspiration	0	0	0	0	52.99	114.8	66.36	93.64	55.72	29.09	0	0	412.65
1963													
Precipitation	29.7	31.5	20.9	95.8	46.3	128.6	91.2	54.7	34	34.6	61	18.8	647.1
Rain	0	0	0	24.7	46.3	128.6	91.2	54.7	34	34.6	21	0	435.1
Snow	29.7	31.5	20.9	71.1	0	0	0	0	0	0	40	18.8	212
Snow Melt and Rain	0	0	6	135.6	165.9	128.6	91.2	54.7	34	34.6	27.6	0	678.27
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	40.35	105.3	138.4	102.2	54.11	48.04	0	0	488.47
Actual Evapotranspiration	0	0	0	0	40.35	105.3	138.4	71.74	37.34	36.82	0	0	430
1964													
Precipitation	65.4	20.1	23.7	31.4	60.7	67.5	63.2	98.5	107.6	37.9	19.4	32.3	627.7
Rain	0	0	0	1.3	60.7	67.5	63.2	98.5	101.7	18.8	0.6	0	412.3
Snow	65.4	20.1	23.7	30.1	0	0	0	0	5.9	19.1	18.8	32.3	215.4
Snow Melt and Rain	0	0	0	191.6	61.94	67.5	63.2	98.5	107.6	37.9	0.6	0	628.8
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	68.73	99.07	132.5	92.13	57.6	19.53	0	0	469.59
Actual Evapotranspiration	0	0	0	0	68.73	98.38	102.5	92.13	57.6	19.53	0	0	438.84

1965													
Precipitation	31.9	29.8	21.1	25.2	84.5	56	89.8	51.8	55.9	88.1	40.9	23.9	598.9
Rain	0	0	0	3.8	80.4	56	89.8	51.8	54.1	80.2	0	0	416.1
Snow	31.9	29.8	21.1	21.4	4.1	0	0	0	1.8	7.9	40.9	23.9	182.8
Snow Melt and Rain	0	0	0	125.5	118.1	56	89.8	51.8	55.9	86.6	0	0	583.7
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	59.25	107.5	113	94.95	52.34	19.87	0	0	446.92
Actual Evapotranspiration	0	0	0	0	59.25	107.5	95.95	59.1	52.34	19.87	0	0	394.02
1966													
Precipitation	58	22.6	43.2	33.9	52.9	171.3	63.5	42.5	72.2	70.6	15.7	25.6	672
Rain	0	0.3	0	11.2	48.3	171.3	63.5	42.5	72.2	26.1	1.8	0	437.2
Snow	58	22.3	43.2	22.7	4.6	0	0	0	0	44.5	13.9	25.6	234.8
Snow Melt and Rain	0	3	5.1	46.78	222	171.3	63.5	42.5	72.2	40.2	5.41	0	672.01
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	34.84	107.7	132.4	103.7	66.82	8.51	0	0	453.97
Actual Evapotranspiration	0	0	0	0	34.84	107.7	132.4	52.55	66.82	8.51	0	0	402.82
1967													
Precipitation	27.7	13.9	24	39.6	56.5	24.6	120.9	39.9	55.1	61.9	30.9	57.2	552.2
Rain	0	0	3.1	0.8	26.5	24.6	120.9	39.9	55.1	34.4	1.8	0	307.1
Snow	27.7	13.9	20.9	38.8	30	0	0	0	0	27.5	29.1	57.2	245.1
Snow Melt and Rain	0	0	23.62	10.11	194.3	24.6	120.9	39.9	55.1	48.34	6.94	0	523.77
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	21.31	106.8	123.6	107.6	76.14	13.79	0	0	449.26
Actual Evapotranspiration	0	0	0	0	21.31	106.8	121.3	50.6	58.33	13.79	0	0	372.17
1968													
Precipitation	20.1	14.5	26.7	73.1	39.1	83.3	118.7	88.9	15	180.4	48.7	15.4	723.9
Rain	0	0	10.6	28.3	38.6	83.3	118.7	88.9	15	177.9	14.7	0	576
Snow	20.1	14.5	16.1	44.8	0.5	0	0	0	0	2.5	34	15.4	147.9
Snow Melt and Rain	0	0	53.37	159.1	55.78	83.3	118.7	88.9	15	180.4	14.7	0	769.22
Surface Runoff	6.09	4.63	4.68	7.53	58.58	60.61	56.03	46	35.25	48.09	58.47	24.9	410.86
Potential Evapotranspiration	0	0	0	0	66.25	99.91	112.1	95.3	82.03	22.18	0	0	477.78
Actual Evapotranspiration	0	0	0	0	66.25	99.36	112.1	94.89	70.11	22.18	0	0	464.9
1969													
Precipitation	94.5	6	9	5.9	64.6	222.4	47	104	164.4	35.5	84.3	14.7	852.3
Rain	0	0	0	3.6	50.1	222.4	47	104	164.4	18.5	7.9	0	617.9
Snow	94.5	6	9	2.3	14.5	0	0	0	0	17	76.4	14.7	234.4
Snow Melt and Rain	0	0	0	164.8	64.6	222.4	47	104	164.4	35.5	8.2	0	810.9
Surface Runoff	14.73	8.16	5.63	4.67	79.08	69.18	91.77	37.32	45.84	71.89	33.81	18.51	480.6
Potential Evapotranspiration	0	0	0	0	41.56	76.14	131.8	123.1	51.32	0	0	0	423.97

Actual Evapotranspiration	0	0	0	0	41.56	76.14	131.9	107	51.32	0	0	0	407.88
1970													
Precipitation	23.3	13.8	21.8	27.2	62.4	52.6	119.4	138.2	123.6	89.6	31.5	50.7	754.1
Rain	0	0	0	17.5	61.4	52.6	119.4	138.2	123.6	84.7	7.1	0	604.5
Snow	23.3	13.8	21.8	9.7	1	0	0	0	0	4.9	24.4	50.7	149.6
Snow Melt and Rain	0	0	9.3	122.9	107.2	52.6	119.4	138.2	123.6	89.6	7.1	0	769.8
Surface Runoff	11.92	7.7	6.25	4.78	52.98	53.41	33.35	37.73	58.42	76.59	40.91	24.27	408.3
Potential Evapotranspiration	0	0	0	0	34.88	107.7	133.3	110.6	58.86	30.96	0	0	476.32
Actual Evapotranspiration	0	0	0	0	34.88	107.7	122	110.6	58.86	30.96	0	0	464.98
1971													
Precipitation	23.7	58.5	16.6	95.4	36.8	49.7	186.6	41.2	130.8	98.6	40.9	58.9	837.7
Rain	0	0	0	19.1	36.8	49.7	186.6	41.2	130.8	80.3	0.3	0	544.8
Snow	23.7	58.5	16.6	76.3	0	0	0	0	0	18.3	40.6	58.9	292.9
Snow Melt and Rain	0	0	0	142.9	163.2	49.7	186.6	41.2	130.8	86.94	2.1	0	803.44
Surface Runoff	13.96	7.95	5.83	8.2	134.6	47.28	26.94	59.83	19.72	55.64	35.96	15.98	431.92
Potential Evapotranspiration	0	0	0	0	47.89	111.5	113.2	104	66.78	31.29	0	0	474.68
Actual Evapotranspiration	0	0	0	0	47.89	111.5	113.2	104.1	66.78	31.29	0	0	474.7
1972													
Precipitation	42.1	14.2	24.7	7.6	68	61	155.1	64	120.1	76.9	49	34.6	717.3
Rain	0	0	0.3	2.6	53.5	61	155.1	64	115.3	45.2	0	0	497
Snow	42.1	14.2	24.4	5	14.5	0	0	0	4.8	31.7	49	34.6	220.3
Snow Melt and Rain	0	0	12.31	135.3	118.4	61	155.1	64	120.1	58.1	0	0	724.26
Surface Runoff	10.02	6.95	5.96	4.92	54.18	45.84	24.01	33.63	20.85	48.22	31.6	17.1	303.29
Potential Evapotranspiration	0	0	0	0	67.02	112.8	117.4	109.2	50.32	0	0	0	456.66
Actual Evapotranspiration	0	0	0	0	67.02	112.8	117.4	107.2	50.32	0	0	0	454.63
1973													
Precipitation	22.9	18.4	34.3	60.1	33.5	88.1	72	156.7	46.9	58.4	79.9	24	695.2
Rain	0	0	1	11	29	88.1	72	156.7	46.9	57.1	3	0	464.8
Snow	22.9	18.4	33.3	49.1	4.5	0	0	0	0	1.3	76.9	24	230.4
Snow Melt and Rain	0	0	28.33	69.64	173.6	88.1	72	156.7	46.9	58.4	7.25	0	700.95
Surface Runoff	9.24	5.99	5.7	6.68	74.48	47.1	51.09	12.53	14.34	22.52	18.18	12.77	280.6
Potential Evapotranspiration	0	0	0	0	44.55	99.14	126	122.5	57.27	32.42	0	0	481.85
Actual Evapotranspiration	0	0	0	0	44.55	99.14	124.1	122.5	54.75	32.42	0	0	477.42
1974													
Precipitation	32.9	13.1	44.3	53.7	65.2	89.7	186.8	208.7	58.1	39.4	61.5	31.1	884.5
Rain	0	0	0	9.7	62.6	89.7	186.8	208.7	58.1	32.3	0	0	647.9
Snow	32.9	13.1	44.3	44	2.6	0	0	0	0	7.1	61.5	31.1	236.6
Snow Melt and Rain	0	0	0	103.3	202.6	89.7	186.8	208.7	58.1	39.4	7.9	0	896.45

Surface Runoff	8.77	5.87	5.23	4.72	48.08	127.7	48.85	25.84	61.59	40.31	20.82	14.35	412.12
Potential Evapotranspiration	0	0	0	0	30.7	102.8	137.6	103.2	45.61	0	0	0	419.9
Actual Evapotranspiration	0	0	0	0	30.7	102.8	137.6	103.2	45.61	0	0	0	419.9
1975													
Precipitation	39.5	9.7	18.7	21.2	51.7	99.6	229.1	146.9	50.7	59.9	35.2	24	786.2
Rain	0	0	0	6.2	45.6	99.6	229.1	146.9	50.7	45.7	6.9	0	630.7
Snow	39.5	9.7	18.7	15	6.1	0	0	0	0	14.2	28.3	24	155.5
Snow Melt and Rain	0	0	14.1	133	78.37	99.6	229.1	146.9	50.7	59.9	18.9	0	830.6
Surface Runoff	11.09	8.18	7.76	7.25	47.97	57.01	53.03	81.49	34.23	22.34	18.74	9.04	358.13
Potential Evapotranspiration	0	0	0	0	70.4	115.9	127.9	103.3	54.21	21.2	0	0	492.89
Actual Evapotranspiration	0	0	0	0	70.4	115.9	127.9	103.3	54.22	21.2	0	0	492.89
1976													
Precipitation	26.8	30	50.7	46	27.8	98.8	71.5	117.1	123.9	14.9	43.3	37	687.8
Rain	0	0.3	5.6	9.1	7.2	98.8	71.5	117.1	123.9	6.1	10.7	0	450.3
Snow	26.8	29.7	45.1	36.9	20.6	0	0	0	0	8.8	32.6	37	237.5
Snow Melt and Rain	0	2.1	18.26	155.7	45.55	98.8	71.5	117.1	123.9	14.9	10.7	0	658.5
Surface Runoff	5.75	4.2	4.02	16.66	112.5	34.82	17.71	10.48	6.36	7.75	5.67	3.89	229.83
Potential Evapotranspiration	0	0	0	0	49.07	114.9	129.7	111.8	58.73	9.56	0	0	473.66
Actual Evapotranspiration	0	0	0	0	49.07	114.7	126.1	111.8	58.73	9.56	0	0	469.84
1977													
Precipitation	30.4	51.6	14.2	14.5	61.1	67	106.9	105.7	84.2	30.6	85.6	26	677.8
Rain	0	0	2.9	13.2	34.8	67	106.9	105.7	84.2	30.2	12.1	0	457
Snow	30.4	51.6	11.3	1.3	26.3	0	0	0	0	0.4	73.5	26	220.8
Snow Melt and Rain	0	0	16.72	163.6	61.1	67	106.9	105.7	84.2	30.6	12.1	0	647.9
Surface Runoff	4.37	3.34	3.31	23.48	51.8	32.4	37.82	27.83	45.63	29.05	15.53	10.65	285.2
Potential Evapotranspiration	0	0	0	5.89	85.08	102.4	122.4	89.67	61	31.45	0	0	497.9
Actual Evapotranspiration	0	0	0	5.89	85.08	97.61	110	89.67	61	31.4	0	0	480.62
1978													
Precipitation	8.5	21.1	41.2	28.6	71.6	60.8	71.6	160.6	88.6	38	41.8	21	653.4
Rain	0	0	0	0	71.6	60.8	71.6	160.6	88.6	29.6	16.6	0	499.4
Snow	8.5	21.1	41.2	28.6	0	0	0	0	0	8.4	25.2	21	154
Snow Melt and Rain	0	0	0	74.7	195.8	60.8	71.6	160.6	88.6	38	18.2	0	708.3
Surface Runoff	7.7	5.38	4.76	3.99	60.62	61.11	29.56	42.83	55.81	33.27	24.38	14.18	343.6
Potential Evapotranspiration	0	0	0	0	69.48	92.01	126.1	101.7	54.11	16.86	0	0	460.23
Actual Evapotranspiration	0	0	0	0	69.48	92.02	110.1	101.7	54.11	16.86	0	0	444.26
1979													
Precipitation	12.4	22	42.7	44.2	79.7	84.8	103.4	85.5	113.4	93.9	73.9	26.6	782.5
Rain	0	0	18.7	42.4	73.6	84.8	103.4	85.5	113.4	68.3	4.8	0	594.9

Snow	12.4	22	24	1.8	6.1	0	0	0	0	25.6	69.1	26.6	187.6
Snow Melt and Rain	0	0	49.49	116.4	79.7	84.8	103.4	85.5	113.4	90.89	7.81	0	731.4
Surface Runoff	8.49	5.66	5.13	7.31	52.97	47.82	33.25	38.47	60.1	49.92	45.57	21.44	376.13
Potential Evapotranspiration	0	0	0	0	53.23	108.7	132.9	95.88	53.36	4.74	0	0	448.85
Actual Evapotranspiration	0	0	0	0	53.23	108.7	128.9	88.71	53.36	4.74	0	0	437.72
1980													
Precipitation	40	7.3	22.7	11.5	14.8	87.9	60	59.6	102.1	94.9	15.1	18.2	534.1
Rain	0	0	0	3.4	14.8	87.9	60	59.6	102.1	50.4	2.6	0	380.8
Snow	40	7.3	22.7	8.1	0	0	0	0	0	44.5	12.5	18.2	153.3
Snow Melt and Rain	0	0	14.1	163.1	14.8	87.9	60	59.6	102.1	60.74	6.85	0	569.18
Surface Runoff	10.96	6.47	5.46	13.67	62.41	23.93	14.82	10.87	13.62	40.45	24.93	10.86	238.43
Potential Evapotranspiration	0	0	0	0	75.19	97.67	130.9	113.1	46.3	0	0	0	463.21
Actual Evapotranspiration	0	0	0	0	75.2	89.54	71.86	68.27	46.3	0	0	0	351.18
1981													
Precipitation	9	40.9	22.6	40.5	28.6	49.3	38.7	38.8	61.9	40.6	59.4	24.8	455.1
Rain	0	8.4	7.8	1	24.4	49.3	38.7	38.8	61.9	24.4	27	0	281.7
Snow	9	32.5	14.8	39.5	4.2	0	0	0	0	16.2	32.4	24.8	173.4
Snow Melt and Rain	0	29.48	24.77	50.55	97.03	49.3	38.7	38.8	61.9	40.6	33.2	0	464.32
Surface Runoff	6.35	4.3	4.33	4.11	54.88	41.58	22.72	8.84	5.63	8.77	16.83	9.97	188.32
Potential Evapotranspiration	0	0	0	0	48.16	96.52	140.2	119.4	55.24	12.55	0	0	472.05
Actual Evapotranspiration	0	0	0	0	48.16	96.53	75.06	51.5	55.24	12.55	0	0	339.04
1982													
Precipitation	32.2	18.3	57.4	54.2	91.2	101.2	77	90.4	136.4	75.2	37.6	39.8	810.9
Rain	0	0	7	7.8	91.2	101.2	77	90.4	136.4	65.8	22.2	4.6	603.6
Snow	32.2	18.3	50.4	46.4	0	0	0	0	0	9.4	15.4	35.2	207.3
Snow Melt and Rain	0	0	19.97	128.6	155.7	101.2	77	90.4	136.4	75.2	29.4	12.8	826.7
Surface Runoff	6.49	3.98	3.38	3.74	73.21	68.34	37.13	22.94	36.21	43.44	30.86	14.86	344.58
Potential Evapotranspiration	0	0	0	0	76.06	86.39	130.2	94.94	62.22	24.55	0	0	474.37
Actual Evapotranspiration	0	0	0	0	76.06	86.39	130.2	91.43	62.22	24.55	0	0	470.87
1983													
Precipitation	40.6	7	41.9	15.6	31.2	77.8	98.1	61.3	64.4	49.4	100.9	16.6	604.8
Rain	0	0	0	6.8	22	77.8	98.1	61.3	64.4	49	12.6	0	392
Snow	40.6	7	41.9	8.8	9.2	0	0	0	0	0.4	88.3	16.6	212.8
Snow Melt and Rain	0	0	0	86.06	85.44	77.8	98.1	61.3	64.4	49.4	18.8	0	541.3
Surface Runoff	8.61	5.54	4.92	4.73	23.85	30.89	52.35	21.75	10.35	15.71	15.18	11.87	205.72
Potential Evapotranspiration	0	0	0	0	21.99	109.3	138.6	122.9	66.91	23.89	0	0	483.65
Actual Evapotranspiration	0	0	0	0	21.99	109.3	126.5	71.67	64.81	23.89	0	0	418.15
1984													

Precipitation	26	18.6	17	50.6	34.8	97	114	63.1	69.9	48.7	65.5	63.7	668.9
Rain	0	1.4	0	48.2	32.2	97	114	63.1	69.9	36.1	0	0	461.9
Snow	26	17.2	17	2.4	2.6	0	0	0	0	12.6	65.5	63.7	207
Snow Melt and Rain	0	1.7	0	206.8	37.2	97	114	63.1	69.9	41.3	1.5	0	632.5
Surface Runoff	8.47	5.58	4.12	14.6	56.1	49.75	29.72	16.28	8.19	9.77	11.07	10.18	223.84
Potential Evapotranspiration	0	0	0	25.38	50.45	104.4	130.7	124.6	48.81	25.55	0	0	509.84
Actual Evapotranspiration	0	0	0	25.38	50.45	104.1	129.6	100.2	48.81	25.55	0	0	484.1
1985													
Precipitation	16.3	10.2	33.6	94	74.8	151.8	79.2	105.9	141.8	47.4	57.4	26.4	838.8
Rain	0	0	2.4	68.4	74.8	151.8	79.2	105.9	141.8	25.6	21.8	0	671.7
Snow	16.3	10.2	31.2	25.6	0	0	0	0	0	21.8	35.6	26.4	167.1
Snow Melt and Rain	0	0	19.3	261.4	83.28	151.8	79.2	105.9	141.8	47.4	21.8	0	911.9
Surface Runoff	8.49	5.98	5.19	6.28	107	81.58	58.49	32.66	39.82	66.92	43.18	19.58	475.18
Potential Evapotranspiration	0	0	0	0	57.14	96.44	120.8	107.1	61.3	22.42	0	0	465.2
Actual Evapotranspiration	0	0	0	0	57.14	96.44	120.8	106.5	61.3	22.42	0	0	464.58
1986													
Precipitation	22.6	22.8	28.4	102.9	40	46.2	90.2	52.8	92	48.6	52.6	35.2	634.3
Rain	0	0	8	72.2	39.8	46.2	90.2	52.8	92	27.3	0	0	428.5
Snow	22.6	22.8	20.4	30.7	0.2	0	0	0	0	21.3	52.6	35.2	205.8
Snow Melt and Rain	0	0	40.28	185.3	53.09	46.2	90.2	52.8	92	35.8	0	0	595.7
Surface Runoff	10.68	5.94	4.88	10.76	80.98	35.1	20.19	12.27	8.32	17.58	18.52	11.74	236.95
Potential Evapotranspiration	0	0	0	6.46	80.68	95.19	127.9	106.6	50.04	11.89	0	0	478.73
Actual Evapotranspiration	0	0	0	6.46	80.69	84.69	96.44	61.55	50.04	11.89	0	0	391.75
1987													
Precipitation	15	15	28.8	31.4	41	95.2	115	192.3	37.9	50.1	22.4	26.7	670.8
Rain	0	0	7	31.4	41	95.2	115	192.3	37.9	36.4	10.5	0.8	567.5
Snow	15	15	21.8	0	0	0	0	0	0	13.7	11.9	25.9	103.3
Snow Melt and Rain	0	0	50.19	140.6	41	95.2	115	192.3	37.9	39	25.04	3.5	739.74
Surface Runoff	7.23	4.64	4.57	12.95	41.94	23.41	20.73	26.47	34.99	22.72	17.19	11.03	227.86
Potential Evapotranspiration	0	0	0	26.18	72.1	110.6	125	99.86	69.29	3.9	0	0	506.97
Actual Evapotranspiration	0	0	0	26.18	72.11	106.1	119.7	99.86	69.3	3.9	0	0	497.2
1988													
Precipitation	28.4	20.7	46	17.4	51.6	52.4	79.2	97.2	144	52.4	64.6	42.4	696.3
Rain	0	0	0	3.8	51.4	52.4	79.2	97.2	144	41.6	0	0	469.6
Snow	28.4	20.7	46	13.6	0.2	0	0	0	0	10.8	64.6	42.4	226.7
Snow Melt and Rain	0	0	0	144.2	51.6	52.4	79.2	97.2	144	42.6	13.5	0	624.66
Surface Runoff	6.82	4.03	3.43	9.69	37.5	25.68	18.81	12.78	24.49	41.82	25.59	18.58	229.21
Potential Evapotranspiration	0	0	0	4.8	67.95	111.2	133.4	112.8	58.19	8.46	0	0	496.89
Actual Evapotranspiration	0	0	0	4.8	67.95	108.1	88.03	99.68	58.19	8.46	0	0	435.25

Table 38. Monthly and annual hydrologic budget for the Albany River drainage basin.

Meteorologic Station Name: Fort Albany
Meteorologic Station Number: 6072460
Streamflow Station Name: Albany River near Hat Island
Streamflow Station Number: 04HD001

(All values in mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1984													
Precipitation	19.5	18.6	14	0	72.2	153	263	134.2	54.7	49	12	45	835.3
Rain	0	0	0	0	35.2	131	263	134.2	45.7	37.6	1	0	647.8
Snow	19.5	18.6	14	0	37	22	0	0	9	11.4	11	45	187.5
Snow Melt and Rain	0	9.9	0	42.2	36.2	131	263	134.2	54.7	49	8.83	0	729.13
Surface Runoff	5.99	3.9	3.22	34.6	61.9	51.8	30	21.34	8.79	11.88	10.21	7.36	250.96
Potential Evapotranspiration	-	-	-	-	-	-	-	-	-	-	-	-	
Actual Evapotranspiration	-	-	-	-	-	-	-	-	-	-	-	-	
1985													
Precipitation	10	29.9	2	0	25.9	66	174	86.8	81	57	13	16	561.1
Rain	0	0	2	0	22.9	60	174	86.8	81	40	0	0	466.2
Snow	10	29.9	0	0	3	6	0	0	0	17	13	16	94.9
Snow Melt and Rain	0	0	67.1	0	25.9	60	174	86.8	81	57	0	0	551.27
Surface Runoff	5.42	4	3.83	32.8	83.1	39.8	34.4	42.02	32.25	59.65	45.12	21.15	403.51
Potential Evapotranspiration	-	-	-	-	-	-	-	-	-	-	-	-	
Actual Evapotranspiration	-	-	-	-	-	-	-	-	-	-	-	-	
1986													
Precipitation	3	14	27	3	0	56.4	43	34	-	95.5	22.2	10	308.1
Rain	0	0	0	1	0	56.4	38	34	-	63.5	0	0	192.9
Snow	3	14	27	2	0	0	5	0	-	32	22.2	10	115.2
Snow Melt and Rain	0	0	0	72	0	56.4	38	34	-	86.43	0	0	286.82
Surface Runoff	9.46	4.6	3.45	21.4	59.1	23.4	19.5	7.81	5.65	19.4	12.66	6.37	192.86
Potential Evapotranspiration	-	-	-	-	-	-	-	-	-	-	-	-	
Actual Evapotranspiration	-	-	-	-	-	-	-	-	-	-	-	-	
1987													
Precipitation	16.6	17	17	29.8	35.4	69.6	60.8	137	54.4	39	30	23	529.6
Rain	0	0	0	18	35.4	69.6	60.8	137	54.4	18	1	0	394.2
Snow	16.6	17	17	11.8	0	0	0	0	0	21	29	23	135.4
Snow Melt and Rain	0	0	21.3	93.6	42.2	69.6	60.8	137	54.4	39	4	0	521.87
Surface Runoff	4.04	2.73	2.7	14.9	20.9	17.7	18.7	21.52	16.62	21.18	13	8.96	163.07

Potential Evapotranspiration	0	0	0	0	73.2	91.7	107	93.86	64.66	7.95	0	0	437.93
Actual Evapotranspiration	0	0	0	0	73.2	72.3	66.3	93.86	64.66	7.95	0	0	378.28
1988													
Precipitation	0	18	22.4	26.4	32.6	1.3	44.4	17.4	66.2	46.2	53.8	34	362.7
Rain	0	0	1.2	18.8	21.2	1.3	44.4	17.4	66.2	30.8	33	0	234.3
Snow	0	18	21.2	7.6	11.4	0	0	0	0	15.4	20.8	34	128.4
Snow Melt and Rain	0	0	3.61	97.2	44.6	1.3	44.4	17.4	66.2	30.8	53.2	0	358.7
Surface Runoff	4.99	2.89	2.57	21.9	65.7	30.9	22.4	20.05	28.66	33.64	27.8	13.21	274.62
Potential Evapotranspiration	0	0	0	0	60.6	77.1	132	104.6	66.29	15.93	0	0	456.19
Actual Evapotranspiration	0	0	0	0	60.6	11.3	55.3	27.7	66.21	15.93	0	0	237

Table 39. Monthly and annual hydrologic budget for the Moose River drainage basin.

Meteorologic Station Name: Moosonee Station
Meteorologic Station Number: 6075425
Streamflow Station Name: Moose River above Moose River
Streamflow Station Number: 04LG004

(All values in mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1982													
Precipitation	42.4	12	32	74.1	32.6	75.3	116.1	87.4	102.3	57	56.2	38	725.4
Rain	0	0	9.3	15.1	32.6	75.3	116.1	87.4	102.3	57	31.6	0.2	526.9
Snow	42.4	12	22.7	59	0	0	0	0	0	0	24.6	37.8	198.5
Snow Melt and Rain	0	0	21.96	128.2	73	75.3	116.1	87.4	102.3	57	51.6	4.8	717.7
Surface Runoff	-	-	-	-	-	-	-	-	-	-	-	-	
Potential Evapotranspiration	0	0	0	0	68.54	94.46	115.4	90.9	65.43	36.19	0	0	470.93
Actual Evapotranspiration	0	0	0	0	68.54	94.46	115.4	87.86	65.43	36.19	0	0	467.89
1983													
Precipitation	27.5	24.5	28.1	36.2	50.4	35.6	68	51.6	75.3	141.5	90.1	19.2	648
Rain	0	0	2.3	11.9	40.3	35.6	68	51.6	75.3	140.5	38.9	0	464.4
Snow	27.5	24.5	25.8	24.3	10.1	0	0	0	0	1	51.2	19.2	183.6
Snow Melt and Rain	0	0	4.12	73.99	126.4	35.6	68	51.6	75.3	141.5	55.1	0	631.6
Surface Runoff	11.27	8.33	12.66	22.69	205.6	90.47	21.43	8.61	22.27	35.85	18.93	13.6	471.7
Potential Evapotranspiration	0	0	0	0	28.6	111.7	117.4	106.5	67.23	27.92	0	0	459.33
Actual Evapotranspiration	0	0	0	0	28.6	111.7	72.58	56.53	67.23	27.92	0	0	364.51
1984													
Precipitation	18.8	38.2	62.2	17.4	71.6	175.4	131.2	43.6	80.3	51.8	43.6	105	839.1
Rain	0	0.4	4.6	17.4	57.4	175.4	131.2	43.6	80.3	49	14.4	0	573.7
Snow	18.8	37.8	57.6	0	14.2	0	0	0	0	2.8	29.2	105	265.4
Snow Melt and Rain	0	13.92	8.88	168	71.6	175.4	131.2	43.6	80.3	49.2	46.2	0	788.3
Surface Runoff	12.59	9.73	12.23	77.25	75.94	49	57.94	17.33	7.95	13.7	24.78	20.3	378.75
Potential Evapotranspiration	0	0	0	14.38	45.54	92.04	122.6	108.4	56.01	34.56	0	0	473.5
Actual Evapotranspiration	0	0	0	14.38	45.54	92.04	122.6	108.4	56.01	34.56	0	0	473.5
1985													
Precipitation	26.3	55.2	16.5	47.6	48	90.5	138.3	84.9	110.6	76.3	76.2	19.5	789.9
Rain	0	0	0	7.2	46.8	90.5	138.3	84.9	110.6	73.5	30.6	0	582.4
Snow	26.3	55.2	16.5	40.4	1.2	0	0	0	0	2.8	45.6	19.5	207.5
Snow Melt and Rain	0	0	2.7	215.7	80.24	90.5	138.3	84.9	110.6	76.3	30.6	0	829.8
Surface Runoff	11.53	8.11	10.41	60.27	115.5	34.94	31.25	25.75	10.38	28.42	24.6	16.5	377.7
Potential Evapotranspiration	0	0	0	0	47.67	94.91	108	104.9	69.55	31.6	0	0	456.6

Actual Evapotranspiration	0	0	0	0	47.67	94.91	108	104.9	69.55	31.6	0	0	456.6
1986													
Precipitation	37.4	23.1	50.3	60.4	15.5	93.6	189.3	103.8	94.1	80.1	43.8	25.6	817
Rain	0	0	9.6	49.6	13.4	93.6	189.3	103.8	94.1	75.1	10.6	1.2	640.3
Snow	37.4	23.1	40.7	10.8	2.1	0	0	0	0	5	33.2	24.4	176.7
Snow Melt and Rain	0	0	23.26	213	15.5	93.6	189.3	103.8	94.1	80.1	12.4	2.4	827.5
Surface Runoff	9.19	7.19	9.47	67.62	87.34	19.15	14.2	15.01	19.17	38.17	22.42	14.1	323.06
Potential Evapotranspiration	0	0	0	1.43	68.27	86.13	118.3	102.4	54.64	17.13	0	0	448.24
Actual Evapotranspiration	0	0	0	1.43	68.27	86.13	118.3	102.4	54.64	17.13	0	0	448.24
1987													
Precipitation	20.6	12.3	21.4	37.3	59.3	52.9	102	158.2	36.4	50.6	60.1	48.6	659.7
Rain	0	0	0	36.8	58.7	52.9	102	158.2	36.4	44.2	42.8	6.9	538.9
Snow	20.6	12.3	21.4	0.5	0.6	0	0	0	0	6.4	17.3	41.7	120.8
Snow Melt and Rain	0	0	43.8	102.2	59.5	52.9	102	158.2	36.4	49	47.6	9.02	660.62
Surface Runoff	12.8	10.02	14.06	46.31	27.55	24.88	24.22	24.62	10.58	25.29	23.56	17.8	261.65
Potential Evapotranspiration	0	0	0	15.45	65.8	98.51	116.1	102.1	67.77	13.93	0	0	479.67
Actual Evapotranspiration	0	0	0	15.45	65.8	85.58	103.6	102.1	67.77	13.93	0	0	454.31
1988													
Precipitation	32.3	34.3	41.2	64.5	79.7	43.3	116	75.3	107	78.1	82.4	38.1	792.2
Rain	0	0	3.4	35.5	79.1	43.3	116	75.3	107	40.3	63.4	0	563.3
Snow	32.3	34.3	37.8	29	0.6	0	0	0	0	37.8	19	38.1	228.9
Snow Melt and Rain	0	0	5.51	144.2	156	43.3	116	75.3	107	47.3	98.7	0	793.28
Surface Runoff	10.05	8.05	8.02	63.16	125.6	25.45	13.56	30.91	21.61	25.7	57.91	30.9	420.94
Potential Evapotranspiration	0	0	0	0	63.09	82.87	123.6	103.9	66.59	15.02	0	0	455.02
Actual Evapotranspiration	0	0	0	0	63.09	82.87	116.9	78.61	66.59	15.02	0	0	423.07
1989													
Precipitation	48.6	12	15	9.5	25.2	39.4	92.1	56.6	90.5	73.6	86.7	19.6	568.8
Rain	0	0	1	6.4	25.2	39.4	92.1	56.6	90.5	56.4	10	0	377.6
Snow	48.6	12	14	3.1	0	0	0	0	0	17.2	76.7	19.6	191.2
Snow Melt and Rain	0	0	9.74	39.19	114	39.4	92.1	56.6	90.5	73.6	22	0	537.1
Surface Runoff	11.71	10.03	10.96	17.23	157.3	55.58	18.49	11.65	8.07	11.07	29.62	14.1	355.81
Potential Evapotranspiration	0	0	0	0	62.1	95.86	115.9	95.85	70.19	29.02	0	0	468.87
Actual Evapotranspiration	0	0	0	0	62.1	95.86	94.6	60.67	70.19	29.02	0	0	412.45
1990													
Precipitation	53.4	28	19.2	36.2	52.2	163.4	66.5	87.8	94.8	61.2	49.4	43.8	755.9
Rain	0	0.4	3	19.2	27.2	163.4	66.5	87.8	94.8	60.8	23.6	0	546.7
Snow	53.4	27.6	16.2	17	25	0	0	0	0	0.4	25.8	43.8	209.2
Snow Melt and Rain	0	6.41	67.1	147.6	52.2	163.4	66.5	87.8	94.8	61.2	29.8	0	776.8

Surface Runoff	10.55	7.11	18.51	63.3	147.9	58.4	40.54	16.75	20.88	50.43	42.43	19.1	495.85
Potential Evapotranspiration	0	0	0	0	42.89	94.34	129.4	104.8	54.6	21.81	0	0	447.75
Actual Evapotranspiration	0	0	0	0	42.89	94.34	129.4	89.52	54.6	21.81	0	0	432.51
1991													
Precipitation	26	5.4	57	23.3	87.6	25.9	64.7	88.6	144	71.6	104.6	26.6	725.3
Rain	0	0	0	22.4	85.4	25.9	64.7	88.6	144	68.2	7	0	506.2
Snow	26	5.4	57	0.9	2.2	0	0	0	0	3.4	97.6	26.6	219.1
Snow Melt and Rain	0	5.7	6.3	163.1	87.6	25.9	64.7	88.6	144	71.6	23.8	0	681.3
Surface Runoff	10.56	8.38	9.51	77.89	70	23.44	7.43	5.91	14.2	38.43	28.66	18.8	313.19
Potential Evapotranspiration	0	0	0	0	61.34	101.8	118.1	106.8	57.93	19.49	0	0	465.41
Actual Evapotranspiration	0	0	0	0	61.34	101.8	69.65	90.23	57.93	19.49	0	0	400.43
1992													
Precipitation	16.8	18.2	24	51.2	46.3	33.3	127.6	109	109.6	67.4	72.2	44.6	720.2
Rain	4	0	0	35.8	43.5	33.3	127.6	109	109.6	52.4	17.6	7.8	540.6
Snow	12.8	18.2	24	15.4	2.8	0	0	0	0	15	54.6	36.8	179.6
Snow Melt and Rain	12.17	0	0	98.27	153.5	33.3	127.6	109	109.6	66	19.4	11.5	740.32
Surface Runoff	9.8	7.4	8.28	30.75	155.4	22.15	20.14	24.37	32.7	41.67	30.71	22.4	405.81
Potential Evapotranspiration	0	0	0	0	66	84.45	104	96.09	72.3	14.1	0	0	436.97
Actual Evapotranspiration	0	0	0	0	66	84.45	104	96.09	72.3	14.1	0	0	436.97
1993													
Precipitation	17.8	14.8	15.2	32.8	2.2	55.8	126.1	79.2	158.2	63.2	15.2	3.8	584.3
Rain	0	0	0	14.8	2.2	55.8	126.1	79.2	158.2	50.6	3.4	0	490.3
Snow	17.8	14.8	15.2	18	0	0	0	0	0	12.6	11.8	3.8	94
Snow Melt and Rain	0	0	54.3	99.64	16.15	55.8	126.1	79.2	158.2	63.2	7.63	0	660.21
Surface Runoff	13.47	9.38	9.96	42.55	122	62.61	28.35	33.25	35.91	35.36	25.38	12.6	430.76
Potential Evapotranspiration	0	0	0	0	64.9	103.7	126.7	111.1	54.14	10.15	0	0	470.71
Actual Evapotranspiration	0	0	0	0	64.9	61.09	126.2	82.61	54.14	10.15	0	0	399.05

Table 40. Monthly and annual hydrologic budget for the Montreal River drainage basin.

Meteorologic Station Name: New Liskeard
Meteorologic Station Number: 6075594
Streamflow Station Name: Montreal River at Lower Notch Generating Station
Streamflow Station Number: 02JD010

(All values in mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1972													
Precipitation	46	28.8	63.7	20.6	28.2	71.9	89	141.5	67.3	34.7	30.9	50.7	673.3
Rain	0	0	1	8.1	28.2	71.9	89	141.5	67.3	26.8	28.9	0	462.7
Snow	46	28.8	62.7	12.5	0	0	0	0	0	7.9	2	50.7	210.6
Snow Melt and Rain	0	0	6.12	169.8	31.63	71.9	89	141.5	67.3	33.2	30.9	0	641.3
Surface Runoff	17.39	23.12	33.22	24.89	90.65	29.66	22.34	30.65	21.99	21.8	20.93	22.51	359.16
Potential Evapotranspiration	0	0	0	0	80.28	102.3	123.3	101.95	64.09	19.9	0	0	491.83
Actual Evapotranspiration	0	0	0	0	80.28	73.74	89	101.95	64.09	19.9	0	0	428.99
1973													
Precipitation	16.8	21.9	41.6	40	86.1	144.5	66.2	88.6	48.7	80	38.8	36.7	709.9
Rain	1.3	0	26.9	33.2	86.1	144.5	66.2	88.6	48.7	80	22.6	2.5	600.6
Snow	15.5	21.9	14.7	6.8	0	0	0	0	0	0	16.2	34.2	109.3
Snow Melt and Rain	25.31	0	105.7	37.2	86.1	144.5	66.2	88.6	48.7	80	28.4	9.13	719.83
Surface Runoff	32.14	27.67	42.64	56.13	79.97	61.59	31.78	22.49	14.77	25.7	27.11	26.78	448.76
Potential Evapotranspiration	0	0	0	17.08	60.58	109.6	127.8	121.17	65.09	39.9	0	0	541.25
Actual Evapotranspiration	0	0	0	17.08	60.58	109.6	116.7	88.6	48.7	39.9	0	0	481.16
1977													
Precipitation	32.7	36.8	61.7	43.5	10.4	72.8	41.2	71.4	62.2	52.1	19.5	28.6	532.9
Rain	0	0	0.8	14	10.4	72.8	41.2	71.4	57.9	52.1	13.5	7.6	341.7
Snow	32.7	36.8	60.9	29.5	0	0	0	0	4.3	0	6	21	191.2
Snow Melt and Rain	0	2.7	80.35	93.35	10.4	72.8	41.2	71.4	57.9	52.1	15	10.65	507.85
Surface Runoff	19.31	18.22	29.98	79.65	58.94	19.07	15.19	10.68	11.79	15.2	22.3	21.96	322.27
Potential Evapotranspiration	0	0	0	17.78	88.92	95.8	127.9	98.65	60.3	26.2	1	0	516.87
Actual Evapotranspiration	0	0	0	17.78	60.89	72.8	41.2	71.4	57.9	26.2	1.36	0	349.49
1978													
Precipitation	55	3	28	37.5	21.2	99.7	75.3	67.4	72.1	67.8	37	50	614
Rain	0	0	0	6.3	21.2	96.5	75.3	67.4	72.1	40.4	0	0	379.2
Snow	55	3	28	31.2	0	3.2	0	0	0	27.4	37	50	234.8
Snow Melt and Rain	0	0	0	79.91	87.25	96.5	75.3	67.4	72.1	42.4	3	0	523.85
Surface Runoff	27.91	27.18	25.04	22.48	77.43	33.21	14.9	13.09	14.13	25.5	22.84	20.61	324.31

Potential Evapotranspiration	0	0	0	0	88.7	96.05	123.5	108.21	58.04	33.2	0	0	507.77
Actual Evapotranspiration	0	0	0	0	88.7	96.05	121.3	70.65	58.04	33.2	0	0	467.92
1979													
Precipitation	36	5	62	75.6	100.1	117.6	117.2	55.4	68.8	122	63.8	13.5	837
Rain	0	0	18	34.3	100.1	117.6	117.2	55.4	68.8	120	34.6	0.5	666.5
Snow	36	5	44	41.3	0	0	0	0	0	2	29.2	13	170.5
Snow Melt and Rain	0	0	60.79	111.2	110.4	117.6	117.2	55.4	68.8	122	62.8	1.4	827.6
Surface Runoff	21.18	25.16	31.69	73.63	165.3	51.62	31.86	18	14.62	26.2	36.31	44.99	540.59
Potential Evapotranspiration	0	0	0	5.51	73.2	109	127.1	93.02	68.9	27.7	0	0	504.41
Actual Evapotranspiration	0	0	0	5.51	73.2	109	127.1	60.25	68.81	27.7	0	0	471.55
1982													
Precipitation	55	27	26.5	11	41	81.5	27.2	78	67.5	75	34.5	11.2	535.4
Rain	0	0	3.5	0	40	81.5	24	78	67.5	65	22	4.7	386.2
Snow	55	27	23	11	1	0	3.2	0	0	10	12.5	6.5	149.2
Snow Melt and Rain	0	0	42.4	52.06	40	81.5	24	78	67.5	65	22	6.2	478.66
Surface Runoff	26.87	25.25	21.19	25.36	56.78	17.44	10.67	4.56	12.06	26.1	29.8	35.64	291.69
Potential Evapotranspiration	0	0	0	0	86.88	88.39	134.5	89.44	62.17	42.9	0	0	504.32
Actual Evapotranspiration	0	0	0	0	86.88	82.05	27.06	78	62.17	42.9	0	0	379.08
1983													
Precipitation	22	4	7.4	0	61	13.8	77.5	63.7	59	84.2	46	8	446.6
Rain	0	0	3	0	54	13.8	77.5	27.7	38	45.6	17	0	276.6
Snow	22	4	4.4	0	7	0	0	36	21	38.6	29	8	170
Snow Melt and Rain	0	0	12.35	12.15	54	13.8	77.5	27.7	38	47.6	30	0	313.1
Surface Runoff	33.94	29.4	23.05	27.67	104.8	74.18	14.79	16.87	11.09	25	21.81	29.11	411.67
Potential Evapotranspiration	0	0	0	16.25	52.07	107.6	132.9	108.7	67.36	27.3	0	0	512.11
Actual Evapotranspiration	0	0	0	16.25	52.07	62.12	77.5	27.7	38	27.3	0	0	300.91

Table 41. Monthly and annual hydrologic budget for the Petawawa River drainage basin.

Meteorologic Station Name: Lake Traverse
Meteorologic Station Number: 6084307
Streamflow Station Name: Petawawa River at Petawawa
Streamflow Station Number: 02KB001

(All values in mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1966													
Precipitation	66.1	25.4	45.5	26.2	42.5	77.9	54.5	108.2	62.3	51.9	158.3	61.8	780.6
Rain	0	0	23.3	23.1	42.5	77.9	54.5	108.2	62.3	43.3	142.1	3.1	580.3
Snow	66.1	25.4	22.2	3.1	0	0	0	0	0	8.6	16.2	58.7	200.3
Snow Melt and Rain	0	7.5	78.45	157.7	42.5	77.9	54.5	108.2	62.3	43.3	166.9	16.44	815.7
Surface Runoff	37.42	23.42	29.06	83.15	82.92	42.86	17.27	9.34	6.33	6.83	20.03	73.25	431.87
Potential Evapotranspiration	0	0	0	19.1	54.26	111.8	132.6	109.3	63.19	32.51	5	0	527.67
Actual Evapotranspiration	0	0	0	19.1	54.26	82.32	64.38	108.3	62.4	32.51	4.95	0	428.25
1967													
Precipitation	57.5	58.1	5.9	63.6	49	150.9	69.9	142	104.5	100.3	49.1	39.7	890.5
Rain	2.5	0	0	63.6	49	150.9	69.9	142	104.5	99.3	31	4.8	717.5
Snow	55	58.1	5.9	0	0	0	0	0	0	1	18.1	34.9	173
Snow Melt and Rain	23.82	0	70.5	136.1	49	150.9	69.9	142	104.5	100.3	39.4	22.57	909.03
Surface Runoff	32.84	20.79	18.51	91.46	71.6	43.72	27.62	10.36	9.41	32.68	58.5	35.71	453.2
Potential Evapotranspiration	0	0	0	18.16	50.26	120.5	127.3	103.9	68.81	32.19	0	0	521.03
Actual Evapotranspiration	0	0	0	18.16	50.26	120.5	127.3	103.9	68.81	32.19	0	0	521.03
1968													
Precipitation	24.9	65.5	36.1	50.8	28.4	96.9	97.5	42.7	71.8	46.1	45	73.3	679
Rain	0	13.7	19.6	50	28.4	96.9	97.5	42.7	71.8	45.6	19.3	0.5	486
Snow	24.9	51.8	16.5	0.8	0	0	0	0	0	0.5	25.7	72.8	193
Snow Melt and Rain	1.8	23.53	128	50.8	28.4	96.9	97.5	42.7	71.8	46.1	27.7	11.32	626.55
Surface Runoff	24.33	16.68	21.16	90.28	41.39	22.38	20.81	11.17	12.2	10.44	9.95	15.67	296.47
Potential Evapotranspiration	0	0	0	35.18	65.87	105.7	125.7	102.9	79.5	42.72	0	0	557.55
Actual Evapotranspiration	0	0	0	35.18	65.87	97.83	100.5	48.85	72.54	42.72	0	0	463.47
1969													
Precipitation	21.8	13.8	46	56.2	108.4	73.3	35.1	49.1	70.7	78.8	57	30.7	640.9
Rain	3.8	0	33	49.3	108.4	73.3	35.1	49.1	70.7	78.3	36	0	537
Snow	18	13.8	13	6.9	0	0	0	0	0	0.5	21	30.7	103.9
Snow Melt and Rain	13.78	2.7	76.63	124	108.4	73.3	35.1	49.1	70.7	78.8	42.4	1.8	676.68
Surface Runoff	16.86	13.39	12.9	74.22	107.3	47.65	23.75	12.3	14.9	13.71	32.16	31.17	400.25

Potential Evapotranspiration	0	0	0	26.02	61.56	99.11	123.2	118.9	70.87	32.32	5	0	536.61
Actual Evapotranspiration	0	0	0	26.02	61.56	99.11	45.43	56.59	70.72	32.32	4.57	0	396.31
1970													
Precipitation	12.5	33.9	59.1	51.9	70.8	62.3	192.4	38.5	83.1	46.9	42.9	59.7	754
Rain	0	0	4.1	21.4	70.8	62.3	192.4	38.5	83.1	46.9	29.2	5.8	554.5
Snow	12.5	33.9	55	30.5	0	0	0	0	0	0	13.7	53.9	199.5
Snow Melt and Rain	0	2.7	16.2	179.5	70.8	62.3	192.4	38.5	83.1	46.9	39.13	9.57	741.1
Surface Runoff	16.42	11.66	12.01	49.45	99.74	39.9	35.2	32.18	15.18	20.29	21.8	26.53	380.36
Potential Evapotranspiration	0	0	0	21.25	68	104.4	128.9	111.2	69.86	37.27	3	0	544.42
Actual Evapotranspiration	0	0	0	21.25	68	104.4	128.9	108.2	69.86	37.27	3.48	0	541.38
1971													
Precipitation	55.7	135	66.6	30.6	39.2	56.3	30.8	66.6	60.9	37.5	86.5	66.8	732.5
Rain	0	8.9	7.6	29.6	39.2	56.3	30.8	66.6	60.9	37.5	18.8	2.5	358.7
Snow	55.7	126.1	59	1	0	0	0	0	0	0	67.7	64.3	373.8
Snow Melt and Rain	0	24.46	25.86	291.5	39.2	56.3	30.8	66.6	60.9	37.5	50.4	40.15	723.65
Surface Runoff	20.57	16.72	19.36	71.76	107.8	34.33	12.69	6.36	5.26	5.89	6.5	15.27	322.46
Potential Evapotranspiration	0	0	0	13.83	74.51	108.7	116.6	104.5	79.88	50.94	0	0	548.93
Actual Evapotranspiration	0	0	0	13.83	74.51	61.96	39.6	70.17	62.62	38.7	0	0	361.39
1972													
Precipitation	40.8	72.7	61.4	52.8	63.6	136.1	103.8	150.1	65.3	92.6	54.3	116.8	1010.3
Rain	0	0	8.1	52	63.6	136.1	103.8	150.1	65.3	90	42.4	0	711.4
Snow	40.8	72.7	53.3	0.8	0	0	0	0	0	2.6	11.9	116.8	298.9
Snow Melt and Rain	6	0	25.43	234.5	88.1	136.1	103.8	150.1	65.3	92.6	48.83	0	950.79
Surface Runoff	16.68	13.53	13.3	38	160.1	58.33	48.43	38.31	29.88	33.77	55.8	35.56	541.7
Potential Evapotranspiration	0	0	0	3.78	80.43	100.7	126.2	104	70.6	22.56	0	0	508.3
Actual Evapotranspiration	0	0	0	3.78	80.43	100.7	126.2	104	70.6	22.56	0	0	508.3
1973													
Precipitation	40.5	33.7	63.6	81.9	65.6	191.4	98.1	48.2	35.2	82.4	64.3	69.8	874.7
Rain	10.2	0	28	73	65.6	191.4	98.1	48.2	35.2	82.4	36.3	12.2	680.6
Snow	30.3	33.7	35.6	8.9	0	0	0	0	0	0	28	57.6	194.1
Snow Melt and Rain	40.14	0	212.8	89.08	65.6	191.4	98.1	48.2	35.2	82.4	48.76	25.35	936.97
Surface Runoff	30.83	26.79	46.23	144.8	85.96	59.14	42.43	25.64	12.43	14.84	18.08	29.72	536.91
Potential Evapotranspiration	0	0	4	21.71	64.3	113.9	129.1	122.1	67.46	42.53	0	0	565.15
Actual Evapotranspiration	0	0	4.03	21.71	64.3	113.9	129.1	56.49	38.56	42.53	0	0	470.62
1974													
Precipitation	55.9	41.4	48.5	93.2	127.4	47.1	70.9	71.2	94.9	48.6	71.9	45.4	816.4
Rain	11.4	0	0.8	91.9	127.4	47.1	70.9	71.2	94.9	45.8	58.9	8.7	629
Snow	44.5	41.4	47.7	1.3	0	0	0	0	0	2.8	13	36.7	187.4

Snow Melt and Rain	34.56	0	75.22	189.2	127.4	47.1	70.9	71.2	94.9	48.6	64.36	18.08	841.54
Surface Runoff	22.46	19.51	25.22	97.77	140.8	46.91	21.38	11.82	8.65	16.32	26.56	27.09	464.44
Potential Evapotranspiration	0	0	0	25.96	60.52	110.5	125.5	111.6	62.36	25.46	0	0	521.78
Actual Evapotranspiration	0	0	0	25.96	60.52	110.5	75.32	73.11	62.36	25.46	0	0	433.2
1975													
Precipitation	67.5	35.3	40.5	39.8	21.6	44.3	81.1	28.7	76.7	59.7	74.7	50.6	620.5
Rain	0	1.3	17.8	3	21.6	44.3	81.1	28.7	76.7	59.7	52.6	0	386.8
Snow	67.5	34	22.7	36.8	0	0	0	0	0	0	22.1	50.6	233.7
Snow Melt and Rain	19.5	11.21	26.54	160.7	21.6	44.3	81.1	28.7	76.7	59.7	74.7	0	604.76
Surface Runoff	18.83	14.6	16.27	44.25	91.38	26.13	10.79	7.96	5.8	10.63	12.36	25.88	284.89
Potential Evapotranspiration	0	0	0	2.29	90.65	114	132.6	112.8	61.82	34.76	10	0	558.58
Actual Evapotranspiration	0	0	0	2.29	90.65	44.94	81.1	28.7	61.82	34.76	9.67	0	353.93
1976													
Precipitation	40	74	111	11.4	94.9	50.9	88.9	57.8	77	31.5	21	69.5	727.9
Rain	0	0	36.1	11.4	94.9	50.9	88.9	57.8	77	25.4	0	0	442.4
Snow	40	74	74.9	0	0	0	0	0	0	6.1	21	69.5	285.5
Snow Melt and Rain	0	0.9	147.7	138.4	94.9	50.9	88.9	57.8	77	31.5	14.4	0	702.4
Surface Runoff	18.17	13.59	27.55	138.2	68.36	31.14	32.89	12.27	7.68	8.65	9.36	11.97	379.81
Potential Evapotranspiration	0	0	0	35.28	64.32	122.1	121.7	105.1	65.9	19.58	0	0	533.94
Actual Evapotranspiration	0	0	0	35.28	64.32	120.6	88.9	57.8	65.9	19.58	0	0	452.36
1977													
Precipitation	53.1	31.2	32	45.2	25.7	55.1	45.5	81	87.1	67.4	123.8	74.1	721.2
Rain	0	5.8	5.1	43.7	25.7	55.1	45.5	81	87.1	47.1	73.7	0	469.8
Snow	53.1	25.4	26.9	1.5	0	0	0	0	0	20.3	50.1	74.1	251.4
Snow Melt and Rain	0	14.32	175.6	45.2	25.7	55.1	45.5	81	87.1	67.4	76.91	0	673.81
Surface Runoff	9.96	7.76	19.39	88.28	46.03	14.86	8.88	5.01	6.58	19.38	26.73	32.82	285.69
Potential Evapotranspiration	0	0	1	30.96	91.56	99.53	128.4	99.3	66.89	26.68	2	0	545.8
Actual Evapotranspiration	0	0	0.69	30.96	91.56	58.6	45.84	81	66.89	26.68	1.76	0	403.98
1978													
Precipitation	49	1.6	23.8	73.7	34.4	55.9	57.2	107.5	80.4	58.7	54.4	47.9	644.5
Rain	0	0	0	43.2	34.4	55.9	57.2	107.5	80.4	58.7	14.5	0	451.8
Snow	49	1.6	23.8	30.5	0	0	0	0	0	0	39.9	47.9	192.7
Snow Melt and Rain	0	0	14.7	204.2	84.57	55.9	57.2	107.5	80.4	58.7	20.1	3.9	687.19
Surface Runoff	21.74	14.88	11.66	48.29	116	32.78	11.19	7.81	11.2	18.98	14.58	16.72	325.82
Potential Evapotranspiration	0	0	0	3.89	88.9	104.5	127.6	110.8	61.48	27.29	0	0	524.4
Actual Evapotranspiration	0	0	0	3.89	88.9	89.86	64.6	107.8	61.48	27.29	0	0	443.84
1979													
Precipitation	99.5	24.6	10.5	65.5	91.4	30.4	87.4	58.8	112.6	112.5	73.4	26	792.6

Rain	0	0	6.5	45.3	91.4	30.4	87.4	55	112.6	108.4	62.4	3.5	602.9
Snow	99.5	24.6	4	20.2	0	0	0	3.8	0	4.1	11	22.5	189.7
Snow Melt and Rain	6	0.9	146.3	125.2	91.4	30.4	87.4	55	112.6	112.5	70.4	17.43	855.53
Surface Runoff	17.21	14.8	21.17	117.3	102.9	33.53	17.71	16.76	12.48	25.13	38.07	41.48	458.54
Potential Evapotranspiration	0	0	0	18.66	77.74	109.5	129.5	104.7	69.38	29.78	5	0	543.93
Actual Evapotranspiration	0	0	0	18.66	77.74	100.1	87.4	55	69.38	29.78	4.76	0	442.81
1980													
Precipitation	60	21	52.2	67	46.8	143.3	102.2	77.7	86.5	104.6	49.4	88.6	899.3
Rain	0	0	44	63.8	46.8	143.3	102.2	77.7	86.5	104.6	18.8	6.3	694
Snow	60	21	8.2	3.2	0	0	0	0	0	0	30.6	82.3	205.3
Snow Melt and Rain	0	0	118.5	93.32	46.8	143.3	102.2	77.7	86.5	104.6	40.2	12.46	825.53
Surface Runoff	25.57	15.28	18.12	107	66.59	38.45	46.33	37.81	26.31	43.58	43.8	33.92	502.8
Potential Evapotranspiration	0	0	0	33.6	80.79	90.29	126.5	116.7	62.18	22.95	0	0	533.06
Actual Evapotranspiration	0	0	0	33.6	80.79	90.29	126.5	82.33	62.18	22.95	0	0	498.68
1981													
Precipitation	19.3	41.2	46.5	72.8	79	93	76.2	117.2	136.6	71	35.5	56.8	845.1
Rain	0	13.4	20	72.8	79	93	76.2	117.2	136.6	53.8	23.1	1.2	686.3
Snow	19.3	27.8	26.5	0	0	0	0	0	0	17.2	12.4	55.6	158.8
Snow Melt and Rain	6.9	133.9	51.5	72.8	79	93	76.2	117.2	136.6	71	23.1	10.22	871.47
Surface Runoff	21.78	28.85	57.89	109.8	63.81	39.39	21.46	17.35	52.63	56.39	31.81	24.76	525.94
Potential Evapotranspiration	0	0	0	31.96	70.86	110.4	129.5	107.8	66.37	22.27	1	0	540.5
Actual Evapotranspiration	0	0	0	31.96	70.86	110.4	82.88	107.8	66.37	22.27	1.36	0	493.85
1982													
Precipitation	79.4	36.3	48.1	43.4	26.6	113	64.2	36	130.1	48.4	88.4	107.4	821.3
Rain	0	0	17.2	40.4	26.6	113	64.2	36	130.1	48.4	55.8	52.8	584.5
Snow	79.4	36.3	30.9	3	0	0	0	0	0	0	32.6	54.6	236.8
Snow Melt and Rain	0	0	78.05	188.1	26.6	113	64.2	36	130.1	48.4	60.61	115	860.11
Surface Runoff	19.09	15.48	15.73	67.94	75.86	30.2	16.96	6.67	9.56	14.72	25.18	50.29	347.68
Potential Evapotranspiration	0	0	0	13.35	90.9	96.93	127.1	95.53	71.61	39.67	3	0	537.76
Actual Evapotranspiration	0	0	0	13.35	90.9	96.93	70.22	41.35	71.61	39.67	2.63	0	426.66
1983													
Precipitation	59.8	56.4	60	73.4	120.4	34.6	40.6	113.8	90.8	86.2	129	108.6	973.6
Rain	3.6	0	40.2	47.2	120.4	34.6	40.6	105	90.8	73	15.8	0	571.2
Snow	56.2	56.4	19.8	26.2	0	0	0	8.8	0	13.2	113.2	108.6	402.4
Snow Melt and Rain	5.12	13.8	121.7	129.2	120.4	34.6	40.6	105	90.8	73	91.07	0	825.24
Surface Runoff	49.62	22.86	31.58	74.5	117.8	46.74	13.24	6.84	8.29	16.44	31.22	32.76	451.84
Potential Evapotranspiration	0	0	0	17.54	58.44	111.8	134.4	117.8	77.51	30.19	0	0	547.66
Actual Evapotranspiration	0	0	0	17.54	58.44	104.3	40.6	105	77.51	30.19	0	0	433.57

1984													
Precipitation	46.8	63.4	35.2	93.2	103.6	67.6	84.3	50.4	62.6	64.6	66.8	69	807.5
Rain	1.2	21.8	5.8	93.2	103.6	67.6	84.3	50.4	62.6	64.6	29	10.6	594.7
Snow	45.6	41.6	29.4	0	0	0	0	0	0	0	37.8	58.4	212.8
Snow Melt and Rain	2.1	99.08	32.69	250.9	103.6	67.6	84.3	50.4	62.6	64.6	66.8	25.8	910.43
Surface Runoff	21.33	22.11	32.96	124.4	87.88	55.31	26.46	13.68	8.87	9.79	22.95	28.75	454.53
Potential Evapotranspiration	0	0	0	35.69	61.88	111.3	123.3	116	62.5	40.03	0	0	550.72
Actual Evapotranspiration	0	0	0	35.69	61.88	111.3	88.19	56.72	62.5	40.03	0	0	456.34
1985													
Precipitation	69.4	65.8	83.2	64.8	45.2	76.2	110.2	91	53	57.4	79.8	74.9	870.9
Rain	0	32.6	30	36.6	45.2	76.2	110.2	91	53	57.4	44.6	14	590.8
Snow	69.4	33.2	53.2	28.2	0	0	0	0	0	0	35.2	60.9	280.1
Snow Melt and Rain	0	46.87	99.06	166.5	45.2	76.2	110.2	91	53	57.4	64.6	18.13	828.13
Surface Runoff	30.51	18.23	30.75	112.2	104	24.96	16.88	12.87	13.95	10.65	16.76	24.33	416.09
Potential Evapotranspiration	0	0	0	20.11	77.39	96.62	121.8	105.1	75.7	37.97	0	0	534.73
Actual Evapotranspiration	0	0	0	20.11	77.39	78.47	111.5	92.52	55.41	37.97	0	0	473.33
1986													
Precipitation	65.6	22	82.8	53	151	70	78.8	78	98.2	52.4	13.6	59.4	824.8
Rain	17.4	8.6	19.6	53	151	70	78.8	78	98	52.2	8.6	1	636.2
Snow	48.2	13.4	63.2	0	0	0	0	0	0.2	0.2	5	58.4	188.6
Snow Melt and Rain	38.38	10.15	193.8	53	151	70	78.8	78	98	52.4	13.6	4.9	842.08
Surface Runoff	17.53	12.57	16.68	100.6	58.61	38.8	14.87	12.34	6.11	12.24	12.07	12.91	315.33
Potential Evapotranspiration	0	0	0	43.36	87.26	99	124.2	101.4	64.06	32.1	0	0	551.4
Actual Evapotranspiration	0	0	0	43.36	87.26	99	83.98	80.56	64.06	32.1	0	0	490.32

APPENDIX I

STATIONS WITH LONG-TERM TEMPERATURE DATA LOCATED ABOVE

LATITUDE 45^0 NORTH

Station ID	Station Name	Latitude	Longitude	Elevation (m)
6010387	ATTAWAPISKAT	52°55´N	82°27´W	9
6010738	BIG TROUT LAKE	53°50´N	89°52´W	224
6011305	CENTRAL PATRICIA	51°30´N	90° 9´W	345
6012064	DONA LAKE	51°24´N	90° 7´W	382
6012198	EAR FALLS	50°38´N	93°13´W	361
6014350	LANSDOWNE HOUSE	52°14´N	87°53´W	255
6016525	PICKLE LAKE	51°28´N	90°12´W	391
6016527	PICKLE LAKE A	51°27´N	90°12´W	387
6016890	RAT RAPIDS	51°12´N	90°14´W	375
6016975	RED LAKE A	51° 4´N	93°48´W	386
6016979	RED LAKE FORESTRY	51° 4´N	93°49´W	376
6019548	WINISK	55°16´N	85°13´W	12
6019550	WINISK A	55°14´N	85° 7´W	13
602B300	EMO HOSKINS	48°45´N	93°51´W	351
6020379	ATIKOKAN	48°45´N	91°37´W	395
6020381	ATIKOKAN CLI	48°44´N	91°38´W	391
6020384	ATIKOKAN MARMION	48°48´N	91°35´W	442
6020727	BERGLAND	48°57´N	94°21´W	364
6022010	DEVLIN	48°31´N	93°45´W	335
6022300	EMO	48°38´N	93°48´W	337
6022301	EMO 2	48°45´N	93°53´W	335
6022475	FORT FRANCES	48°37´N	93°25´W	343
6022476	FORT FRANCES A	48°39´N	93°26´W	342
6022480	FORT FRANCES CDA EPF	48°33´N	93°31´W	354
6022487	FORT FRANCES FORESTRY	48°37´N	93°24´W	342
6024010	KAWENE	48°44´N	91°12´W	454
6025203	MINE CENTRE	48°46´N	92°37´W	343
6025407	MOOSE LAKE	48°50´N	91°36´W	396
6026853	RAINY RIVER	48°46´N	94°40´W	329
6027825	SLEEMAN	48°43´N	94°25´W	335
6028125	STRATTON	48°47´N	94° 3´W	358
6028127	STRATTON ROEN	48°51´N	94° 1´W	347
6032117	DRYDEN	49°47´N	92°50´W	372
6032119	DRYDEN A	49°50´N	92°45´W	413
6032122	DRYDEN FORESTRY	49°49´N	92°51´W	373
6032192	EAGLE RIVER	49°49´N	93°13´W	350
6033690	IGNACE	49°25´N	91°39´W	447
6033697	IGNACE TCPL 58	49°29´N	92° 0´W	473
6034075	KENORA A	49°47´N	94°22´W	410
6034077	KENORA TCPL 49	49°47´N	94°29´W	340
6035000	MARTIN	49°15´N	91° 8´W	474
6035002	MARTIN TCPL 60	49°17´N	91°14´W	471
6035190	MINAKI	49°59´N	94°40´W	335
6036904	RAWSON LAKE	49°39´N	93°43´W	358
6037775	SIOUX LOOKOUT A	50° 7´N	91°54´W	390
6037803	SIOUX NARROWS	49°29´N	93°58´W	411
6039130	VALORA	49°45´N	91°13´W	427
6039136	VERMILION BAY TCPL 52	49°50´N	93°38´W	385
6039351	WATCOMB	49°54´N	91°17´W	412
604FNL6	PIGEON RIVER	48° 5´N	89°38´W	290
604HBFA	THUNDER BAY WPCP	48°24´N	89°14´W	184
604HK61	THUNDER BAY PROVINCIAL PAPER	48°27´N	89°10´W	184
604H26A	THUNDER BAY POMBER	48°30´N	89°13´W	229
6040010	ABITIBI CAMP 11	48°56´N	89°21´W	442

6040011	ABITIBI CAMP 11	48°51´N	89° 7´W	491
6040018	ABITIBI CAMP 228	48°56´N	89°15´W	472
6040020	ABITIBI CAMP 230	49°21´N	89°22´W	457
6040022	ABITIBI CAMP 300	49°38´N	89°45´W	427
6040081	AGUASABON	48°47´N	87°10´W	189
6040325	ARMSTRONG A AUT	50°17´N	88°55´W	323
6040330	ARMSTRONG JELLIEN	50°15´N	89° 6´W	341
6040572	BEARDMORE	49°37´N	87°57´W	305
6040785	BLACK STURGEON LAKE	49°19´N	88°51´W	253
6040786	BLACK STURGEON LAKE 2	49°18´N	88°48´W	253
6040790	BLACK STURGEON RIVER	49° 4´N	88°37´W	220
6041036	BURCHELL LAKE	48°37´N	90°35´W	465
6041109	CAMERON FALLS	49° 9´N	88°21´W	229
6041193	CARAMAT	49°16´N	85°50´W	338
6041221	CARIBOU ISLAND	47°20´N	85°50´W	187
6042036	DOG LAKE DAM	48°42´N	89°37´W	420
6042045	DOG RIVER	48°59´N	89°54´W	448
6042063	DONA	48°30´N	89°31´W	317
6042067	DORION TCPL 70	48°49´N	88°31´W	193
6042715	GERALDTON	49°42´N	86°57´W	331
6042716	GERALDTON A	49°47´N	86°56´W	349
6042723	GERALDTON FORESTRY	49°42´N	86°52´W	338
6042755	GERALDTON HYDRO	49°41´N	86°57´W	338
6042975	GRAHAM A	49°16´N	90°35´W	503
6043330	HANOVER TOWER	50°24´N	87°10´W	335
6043452	HEMLO BATTLE MOUNTAIN	48°42´N	85°53´W	335
6043460	HERON BAY SOUTH	48°59´N	85°49´W	297
6043870	JARVIS LAKE	49°15´N	87°49´W	320
6043930	KAKABEKA FALLS	48°24´N	89°37´W	278
6043949	KAMINISTIKWIA	48°33´N	89°24´W	457
6044000	KASHABOWIE	48°36´N	90°36´W	467
6044050	KENOGAMI DAM	49°55´N	86°28´W	312
6044115	KILLALA LAKE	49° 9´N	86°28´W	290
6044138	KINGFISHER LAKE	48°39´N	89° 4´W	488
6044298	LAKEHEAD UNIVERSITY	48°26´N	89°16´W	210
6044525	LONGLAC	49°45´N	86°30´W	317
6044560	LONGLAC P AND P	49°46´N	86°32´W	343
6044595	LONG LAKE CROL DAM	49° 5´N	87° 3´W	317
6044612	LOON	48°38´N	88°46´W	323
6044735	MACDIARMID	49°26´N	88° 9´W	312
6044890	MANITOU FALLS	49°12´N	86° 6´W	N/A
6044959	MARATHON	48°43´N	86°24´W	189
6044961	MARATHON A	48°45´N	86°21´W	316
6045541	MYRT LAKE	48°28´N	90°43´W	518
6045550	NAKINA A	50°11´N	86°42´W	325
6045572	NAKINA FORESTRY	50°11´N	86°42´W	321
6045675	NOLALU	48° 9´N	89°53´W	381
6045676	NOLALU SSW22	48° 6´N	89°53´W	350
6046164	OXALINE LAKE	49°42´N	87°34´W	331
6046281	PAYS PLAT	48°52´N	87°36´W	185
6046283	PAYS PLAT FORESTRY	48°53´N	87°32´W	191
6046549	PINE PORTAGE	49°18´N	88°19´W	233
6046590	PORT ARTHUR CKPR	48°25´N	89°16´W	188
6046811	QUORN	49°25´N	90°54´W	445
6046856	RAITH TCPL 64	48°44´N	89°52´W	433
6046989	REDMOND	50°14´N	87°30´W	326

6047615	SAVANNE	48°58´N	90°12´W	459
6047617	SAVANNE LAKE	48°50´N	90° 6´W	480
6047627	SCHREIBER	48°49´N	87°16´W	302
6047810	SLATE ISLAND	48°37´N	87° 0´W	186
6048K6J	THUNDER BAY MCS CENTRE	48°19´N	89°23´W	232
6048017	STEVENS	49°32´N	85°51´W	325
6048145	STURGEON LAKE	49°53´N	90°58´W	428
6048175	SUMMIT CROL DAM	50°38´N	88°12´W	332
6048261	THUNDER BAY A	48°22´N	89°20´W	199
6048951	TROUT LAKE	48°37´N	89°22´W	457
6049096	UPSALA	49° 3´N	90°28´W	484
6049098	UPSALA TCPL 62	49° 2´N	90°31´W	493
6049175	WABOOSE DAM	50°47´N	87°59´W	329
6049443	WELCOME ISLAND	48°22´N	89° 7´W	209
6050NNP	BAR RIVER	46°26´N	84° 3´W	180
6050801	BLIND RIVER	46°12´N	83° 0´W	183
6050805	BLIND RIVER HYDRO CENTRE	46°12´N	83° 1´W	189
6051R65	DALTON	48° 9´N	84° 2´W	343
605102G	BRUCE MINES RADIGAN	46°18´N	83°45´W	178
6052258	ELLIOT LAKE	46°23´N	82°39´W	312
6052260	ELLIOT LAKE DENISON	46°30´N	82°37´W	434
6052268	ELLIOT LAKE STANLEIGH	46°25´N	82°39´W	374
6052563	FRANZ	48°28´N	84°25´W	373
6052565	FRANZ FORESTRY	48°27´N	84°24´W	372
6053391	HAWK JUNCTION	48° 5´N	84°33´W	328
6053463	HIGH FALLS	47°55´N	84°43´W	221
6053570	HORNEPAYNE	49°14´N	84°48´W	329
6053575	HORNEPAYNE A	49°12´N	84°46´W	335
6053803	IRON BRIDGE	46°16´N	83°21´W	198
6053804	IRON BRIDGE	46°17´N	83°14´W	183
6054078	KENTVALE	46°13´N	84° 4´W	205
6055210	MISSISSAGI HYDRO	46°26´N	83°23´W	226
6055300	MREAL FALLS	47°15´N	84°24´W	408
6056389	PESHU LAKE	46°37´N	83°10´W	N/A
6056907	RAYNER	46°20´N	83°30´W	244
6057327	ST JOSEPH ISLAND MTN	46°12´N	83°57´W	335
6057437	SAND LAKE	47°47´N	84°32´W	373
6057589	SAULT STE MARIE	46°32´N	84°30´W	206
6057592	SAULT STE MARIE A	46°29´N	84°31´W	192
6057597	SAULT STE MARIE INSECTARY	46°28´N	84°28´W	191
6057605	SAULT STE MARIE SHINGWOUK	46°30´N	84°17´W	183
6057678	SEARCHM	46°45´N	84° 5´W	221
6059D09	WAWA A	47°58´N	84°47´W	287
6059210	WALFORD	46°12´N	82°14´W	214
6059211	WALFORD	46°12´N	82°17´W	183
6059408	WAWA	47°58´N	84°47´W	287
6059409	WAWA	48° 0´N	84°48´W	297
6059475	WHITE RIVER	48°36´N	85°17´W	379
6060070	AGNEW MINE	46°26´N	81°37´W	305
6060725	BENNY	46°31´N	81°38´W	387
6060773	BISCOTASING	47°18´N	82° 6´W	407
6061358	CHAPLEAU	47°50´N	83°26´W	428
6061359	CHAPLEAU 2	47°50´N	83°26´W	432
6061361	CHAPLEAU A	47°49´N	83°21´W	447
6061847	CONISTON	46°28´N	80°49´W	237
6061850	CONISTON STP	46°29´N	80°51´W	268
6061870	COPPER CLIFF	46°29´N	81° 3´W	274

6062425	FOLEYET	48°15´N	82°26´W	329
6062665	GARSON	46°34´N	80°52´W	290
6062860	GOGAMA TREE NURSERY	47°41´N	81°43´W	352
6064460	LIVELY	46°26´N	81° 9´W	282
6064942	MANVILLE REEVES	48°13´N	82° 5´W	335
6065005	MASSEY	46°13´N	82° 4´W	188
6065015	MATTAGAMI LAKE DAM	48° 1´N	81°33´W	328
6065020	MATTAGAMI PATROL	47°54´N	81°33´W	329
6065043	MCVITTIES	46°17´N	80°51´W	213
6065250	MONETVILLE	46° 9´N	80°18´W	221
6066873	RAMSAY	47°27´N	82°20´W	430
6066875	RAMSEY	47°25´N	82°19´W	426
6066877	RAMSEY 2	47°28´N	81°52´W	402
6067211	RUEL	47°18´N	81°27´W	410
6067308	ST CHARLES	46°22´N	80°31´W	236
6068148	SUDBURY	46°29´N	80°59´W	259
6068150	SUDBURY A	46°37´N	80°48´W	348
6068155	SUDBURY MOE	46°28´N	81° 2´W	259
6068158	SUDBURY SCIENCE NORTH	46°28´N	81° 0´W	263
6068980	TURBINE	46°23´N	81°34´W	206
6069165	WABAGISHIK	46°19´N	81°31´W	213
6069197	WAHNAPITAE-STOKES	46°26´N	80°43´W	750
6069428	WEBBWOOD	46°16´N	81°53´W	196
6070027	ABITIBI CANYON	49°53´N	81°34´W	204
6071712	COCHRANE	49° 4´N	81° 2´W	275
6071855	CONNAUGHT	48°37´N	80°55´W	281
6072183	DYMOND HYDRO	47°31´N	79°41´W	198
6072225	EARLTON A	47°42´N	79°51´W	243
6072325	ENGLEHART	47°49´N	79°54´W	252
6072460	FORT ALBANY	52°13´N	81°40´W	15
6072595	FREDERICKHOUSE LAKE DAM	48°46´N	80°59´W	284
6073138	HAILEYBURY	47°27´N	79°38´W	189
6073420	HEASLIP	47°48´N	79°50´W	222
6073600	HOUND CHUTE	47°18´N	79°42´W	279
6073630	HUNTA	49° 7´N	81°16´W	274
6073750	INDIAN CHUTE	47°51´N	80°27´W	293
6073960	KAPUSKASING CDA	49°24´N	82°26´W	218
6073975	KAPUSKASING A	49°25´N	82°28´W	227
6074100	KIDD CREEK MINE	48°41´N	81°22´W	277
6074209	KIRKLAND LAKE	48° 9´N	80° 0´W	324
6074620	LOWBUSH	48°55´N	80° 7´W	270
6074630	LOWER STURGEON	48°49´N	81°29´W	247
6075012	MATHESON	48°32´N	80°27´W	259
6075013	MATHESON HYDRO	48°32´N	80°28´W	274
6075024	MATTICE TCPL	49°36´N	83°10´W	233
6075211	MISTINIKON LAKE DAM	48° 3´N	80°43´W	320
6075379	MREAL RIVER	47° 7´N	79°29´W	183
6075425	MOOSONEE UA	51°16´N	80°39´W	10
6075542	NAGAGAMI	49°46´N	84°31´W	244
6075594	NEW LISKEARD	47°30´N	79°40´W	194
6076200	PAGWA A	50° 2´N	85°16´W	189
6076540	PINARD	49°51´N	81°36´W	232
6076575	PORQUIS JUNCTION A	48°44´N	80°48´W	308
6076870	RAMORE TS	48°20´N	80°26´W	287
6077475	SANDY FALLS	48°31´N	81°26´W	262
6077845	SMOKY FALLS	50° 4´N	82°10´W	183
6078280	TIMMINS	48°30´N	81°20´W	335
6078285	TIMMINS A	48°34´N	81°23´W	295

6078290	TIMMINS HYDRO	48°28´N	81°22´W	308
6079040	TWIN FALLS	48°45´N	80°35´W	274
6079068	UPPER NOTCH	47°15´N	79°35´W	241
6079415	WAWAITIN	48°21´N	81°24´W	271
608A06G	CACHE BAY	46°23´N	80° 1´W	198
6080189	ALGONQUIN PARK	45°35´N	78°33´W	433
6080191	ALGONQUIN PARK EAST	45°32´N	78°16´W	412
6080193	ALGONQUIN PARK WEST	45°20´N	78°51´W	427
6080577	BEAR ISLAND	46°59´N	80° 5´W	294
6081928	CRYSTAL FALLS	46°27´N	79°52´W	227
6082178	DWIGHT	45°23´N	78°54´W	404
6084278	LA CAVE	46°22´N	78°44´W	172
6084300	LAKE OPEONGO	45°38´N	78°22´W	403
6084307	LAKE TRAVERSE	45°57´N	78° 4´W	236
6085682	NORTH BAY	46°19´N	79°28´W	201
6085700	NORTH BAY A	46°22´N	79°25´W	370
6085704	NORTH BAY OWRC	46°18´N	79°28´W	198
6086930	RED CEDAR LAKE DAM	46°41´N	80° 1´W	270
6088271	TIMAGAMI	47° 5´N	79°51´W	351
6092915	GORE BAY	45°55´N	82°28´W	191
6092925	GORE BAY A	45°53´N	82°34´W	194
6093004	GREAT DUCK ISLAND	45°39´N	82°58´W	183
6093900	KAGAWONG	45°55´N	82°16´W	180
6094449	LITTLE CURRENT	45°58´N	81°55´W	191
6097915	SOUTH BAYMOUTH	45°35´N	82° 1´W	182
610E061	MERIVALE TS	45°20´N	75°44´W	98
6100172	ALFRED	45°33´N	74°53´W	54
6100174	ALFRED AUTOMATIC CLIMATE STATI	45°33´N	74°53´W	54
6100226	ALME	45°11´N	76°14´W	125
6100284	APPLE HILL	45°13´N	74°45´W	91
6100340	ARNPRIOR	45°26´N	76°23´W	99
6100353	ASHTON	45°12´N	75°58´W	137
6100363	ASHTON STN SESIA FARM	45°10´N	76° 4´W	137
6100493	BARK LAKE DAM	45°25´N	77°48´W	335
6100521	BARRETT CHUTE	45°15´N	76°46´W	160
6100558	BARRY'S BAY	45°26´N	77°40´W	290
6100828	BOURGET	45°28´N	75°10´W	66
6101077	CALABOGIE	45°15´N	76°44´W	155
6101249	CARLETON PLACE	45° 9´N	76°10´W	137
6101260	CARP	45°18´N	75°59´W	114
6101335	CHALK RIVER AEC	46° 3´N	77°22´W	122
6101440	CHATS FALLS	45°28´N	76°14´W	94
6101494	CHENAUX	45°35´N	76°41´W	84
6101500	CHESTERVILLE	45° 6´N	75°14´W	70
6101521	CITY VIEW	45°21´N	75°44´W	88
6101555	CLAYBANK	45°25´N	76°24´W	107
6101658	CLARF	45°23´N	77° 9´W	245
6101675	COBDEN ARIO HYDRO	45°38´N	76°52´W	140
6101820	COMBERMERE	45°22´N	77°37´W	287
6101873	CORNWALL	45° 2´N	74°42´W	59
6101874	CORNWALL	45° 1´N	74°45´W	64
6101880	CORNWALL COLLEGE	45° 2´N	74°43´W	55
6101885	CORNWALL CUMBERLAND ST	45° 3´N	74°45´W	59
6101901	CORNWALL HYDRO	45° 2´N	74°48´W	76
6101909	CORNWALL ST LHS	45° 2´N	74°43´W	53
6101935	CUMBERLAND	45°30´N	75°27´W	91

6101960	DALKEITH	45°26´N	74°37´W	67
6101962	DALKEITH PYM	45°26´N	74°35´W	76
6102009	DES JOACHIMS	46°11´N	77°42´W	130
6102150	DUNROBIN	45°26´N	76° 2´W	66
6102250	EGANVILLE	45°33´N	77° 6´W	165
6102516	FOURNIER	45°26´N	74°54´W	65
6102531	FOYMOUNT	45°20´N	77°18´W	427
6102839	GLOUCESTER DESJARDINS	45°20´N	75°30´W	76
6102840	GLOUCESTER KETTLES	45°21´N	75°33´W	76
6102841	GLOUCESTER RCN	45°18´N	75°31´W	81
6102842	GLOUCESTER TINKER	45°21´N	75°28´W	76
6103006	GREENFIELD	45°21´N	74°40´W	84
6103366	HARROWSMITH			
6103390	HAWKESBURY	45°37´N	74°38´W	46
6104JK5	KILLALOE STATION	45°29´N	77°30´W	396
6104025	KEMPTVILLE	45° 0´N	75°38´W	99
61041BE	KILLALOE O'GRADY	45°30´N	77°29´W	396
6104125	KILLALOE	45°34´N	77°25´W	174
6104293	LAGGAN	45°23´N	74°43´W	91
6104340	LANCASTER	45° 9´N	74°28´W	50
6104400	LEONARD	45°23´N	75°19´W	76
6104931	MANOTICK	45°14´N	75°41´W	87
6104932	MANOTICK	45°14´N	75°42´W	84
6105010	MATAWATCHAN	45° 8´N	77° 7´W	300
6105061	MERIVALE CDA	45°18´N	75°44´W	90
6105066	METCALFE OSGOODE	45°14´N	75°28´W	84
6105395	MOOSE CREEK	45°15´N	75° 2´W	84
6105512	MOUNT ST PATRICK	45°20´N	76°53´W	213
6105576	NAVAN	45°26´N	75°31´W	76
	PRVG GND	45°27´N	75°34´W	89
6105910	OTTAWA ALBION RD	45°20´N	75°38´W	98
6105913	OTTAWA ALTA VISTA	45°23´N	75°45´W	81
6105938	OTTAWA BECKWITH RD	45°24´N	75°40´W	61
6105950	OTTAWA BILLINGS BRIDGE	45°21´N	75°39´W	92
6105960	OTTAWA BRITANNIA	45°22´N	75°48´W	58
6105976	OTTAWA CDA	45°23´N	75°43´W	79
6105980	OTTAWA CITY HALL	45°26´N	75°42´W	56
6105993	OTTAWA HAZELDEAN	45°19´N	75°54´W	107
6105995	OTTAWA HOGS BACK	45°22´N	75°41´W	79
6106000	OTTAWA MACDONALD-CARTIER INT'L	45°19´N	75°40´W	114
6106003	OTTAWA KANATA	45°20´N	75°55´W	101
6106014	OTTAWA LA SALLE ACAD	45°26´N	75°42´W	61
6106052	OTTAWA LEMIEUX ISLAND	45°25´N	75°44´W	61
6106080	OTTAWA NEPEAN	45°23´N	75°45´W	84
6106090	OTTAWA NRC	45°27´N	75°37´W	98
6106098	OTTAWA RIDEAU WARD	45°24´N	75°38´W	71
6106100	OTTAWA ROCKCLIFFE A	45°27´N	75°38´W	54
6106102	OTTAWA SOUTH MARCH	45°21´N	75°56´W	87
6106105	OTTAWA U OF O	45°25´N	75°41´W	66
	MATCH	45°50´N	77° 9´W	125
6106378	PERCH LAKE MAIN IHD	46° 4´N	77°38´W	168
6106398	PETAWAWA A	45°57´N	77°19´W	130
6106400	PETAWAWA NAT FORESTRY	45°59´N	77°26´W	183
6106779	PURDY	45°19´N	77°43´W	491
6106874	RAMSAYVILLE CRF	45°25´N	75°33´W	79
61070AA	RICHMOND	45° 9´N	75°54´W	110
6107004	RENFREW SAND POINT	45°29´N	76°26´W	127

6107010	RICHMOND	45°10´N	75°47´W	99
6107011	RICHMOND	45°11´N	75°51´W	98
6107017	RIDEAU CANAL BOBS			
	LONG ISLAND	45°15´N	75°42´W	84
6107182	ROLPHTON	46°11´N	77°39´W	137
6107184	ROLPHTON NPD	46°11´N	77°40´W	122
6107247	RUSSELL	45°15´N	75°21´W	76
6107310	ST ELMO	45°19´N	74°51´W	84
6107352	ST RAPHAEL	45°13´N	74°35´W	69
6107533	SARSFIELD	45°26´N	75°21´W	85
6107699	SHIRLEY BAY	45°21´N	75°53´W	76
6108027	STEWARTVILLE	45°24´N	76°30´W	131
6109132	VANKLEEK HILL	45°31´N	74°39´W	88
6109590	WOODLAWN	45°30´N	76° 6´W	91
6110605	BEATRICE	45° 8´N	79°23´W	290
6110745	BINGHAM CHUTE	46° 5´N	79°24´W	242
6110851	BRACEBRIDGE	45° 3´N	79°19´W	250
6110854	BRACEBRIDGE HYDRO	45° 2´N	79°18´W	267
61110M6	BURK'S FALLS 2	5° 35´N	79°36´W	310
6111045	BURKS FALLS	45°36´N	79°34´W	320
6112070	DORSET	45°10´N	78°50´W	347
6112072	DORSET MOE	45°13´N	78°56´W	323
6112313	EMSDALE	45°30´N	79°14´W	328
6113660	HUNTSVILLE	45°19´N	79°15´W	290
6113663	HUNTSVILLE WPCP	45°21´N	79°10´W	321
6113665	HUNTSVILLE TAWINGO	45°21´N	79°19´W	290
6114006	KATRINE DOE LAKE	45°32´N	79°24´W	305
6114805	MAGNETAWAN	45°40´N	79°47´W	280
6115150	MILFORD BAY	45° 6´N	79°29´W	252
6115668	NIPISSING	46° 8´N	79°32´W	N/A
6116254	PARRY SOUND	45°20´N	80° 0´W	194
6116255	PARRY SOUND	45°21´N	80° 3´W	198
	VALLEYVIEW	46° 5´N	79°21´W	274
6116843	RAGGED RAPIDS	45° 1´N	79°41´W	229
6117167	ROBERTS LAKE ONT	45°14´N	79°49´W	244
6117189	ROSSEAU LAKE ONT	45°15´N	79°38´W	244
6117663	SCOTIA ONT	45°31´N	79°18´W	390
6117943	SOUTH FALLS ONT	45° 0´N	79°18´W	231
61191LK	VANKOUGHNET	45° 2´N	79° 0´W	305
6119115	UTTERSON HYDRO	45°12´N	79°21´W	297
6119452	WESTERN ISLANDS	45° 2´N	80°22´W	184
6121912	COVE ISLAND	45°20´N	81°44´W	180
6125155	MILLER LAKE FOREST	45° 6´N	81°31´W	198
6128320	TOBERMORY	45°15´N	81°40´W	183
6128323	TOBERMORY			
	CYPRUS LAKE	45°14´N	81°32´W	190
6160465	BANCROFT	45° 3´N	77°51´W	327
6160468	BANCROFT L'AMABLE	45° 0´N	77°48´W	347
6160473	BANCROFT OMNR	45° 3´N	77°52´W	344
6163156	HALIBURTON A	45° 0´N	78°35´W	320
6163170	HALIBURTON 2	45° 3´N	78°29´W	320
6163171	HALIBURTON 3	45° 2´N	78°32´W	330
6163677	HYBLA MARSHALL	45° 9´N	77°51´W	412
6045781	ONE ISLAND LAKE	48°39´N	89°25´W	457
6100285	APPLETON	45°11´N	76° 7´W	133
6100722	BELLS CORNERS	45°20´N	75°49´W	75
6019053	UCHI LAKE	51° 4´N	92°35´W	402
6033695	IGNACE FORESTRY	49°54´N	91°35´W	N/A
6043468	HILLSPORT	49°26´N	85°33´W	316

6044965	MARATHON FORESTRY	48°43´N	86°23´W	214
6047628	SCHREIBER FORESTRY	48°50´N	87°15´W	284
6052259	ELLIOT LAKE A	46°21´N	82°34´W	331
6054456	LITTLE RAPIDS	46°11´N	83°35´W	N/A
6069276	WANAPITEI DAM	46°39´N	80°40´W	274
6073407	HEARST	49°42´N	83°39´W	246
6076884	RANGER LAKE	46°55´N	83°30´W	N/A
6088274	TIMAGAMI ISLAND	46°57´N	80° 3´W	293
6105930	OTTAWA BAYVIEW	45°25´N	75°44´W	55
6106005	OTTAWA KEYWORTH	45°24´N	75°45´W	61
6106110	OTTAWA WOODROFFE	45°22´N	75°46´W	79

APPENDIX II

LONG-TERM PRECIPITATION STATIONS IN NORTHERN ONTARIO

Patricia District

Station Number	Station Name	Latitude	Longitude	Period of Records
6010387	ATTAWAPISKAT	52^0 55'N	82^0 27'W	1968
6010738	BIG TROUT LAKE	53^0 50'N	89^0 52'W	1939-1992
6010739	BIG TROUT LAKE READAC	53^0 49'N	89^0 53'W	1993-1997
6011305	CENTRAL PATRICIA	51^0 30'N	90^0 9'W	1953-1978
6012064	DONA LAKE	51^0 24'N	90^0 7'W	1990
6012198	EAR FALLS	50^0 38'N	93^0 3'W	1928-1996
6012490	FORT HOPE	51^0 33'N	87^0 58'W	1891-1930
6014350	LANSDOWNE HOUSE	52^0 14'N	87^0 53'W	1941-1994
6014353	LANSDOWNE HOUSE (AUT)	52^0 11'N	87^0 48'W	1993-1997
6016295	PEAWANUCK (AUT)	54^0 59'N	85^0 26'W	1993-1997
6016525	PICKLE LAKE	51^0 28'N	90^0 12'W	1930-1990
6016527	PICKLE LAKE A	51^0 27'N	90^0 12'W	1990-1997
6016890	RAT RAPIDS	51^0 12'N	90^0 14'W	1934-1953
6016975	RED LAKE A	51^0 4'N	90^0 48'W	1930-1997
6016979	RED LAKE FORESTRY	51^0 4'N	93^0 49'W	1959-1960
6019548	WINISK	55^0 16'N	85^0 13'W	1968-1979

Rainy River District

6020379	ATIKOKAN	48^0 45'N	91^0 37'W	1966-1988
6020381	ATIKOKAN CLI	48^0 44'N	91^0 38'W	1914-1971
6020384	ATIKOKAN MARMION	48^0 50'N	91^0 35'W	1979-1997
6020559	BARWICK	48^0 38'N	93^0 58'W	1978-1997
6020727	BERGLAND	48^0 57'N	94^0 21'W	1980-1981
6022010	DEVLIN	48^0 31'N	93^0 45'W	1978-1992
6022011	DEVLIN BELLAMY	48^0 38'N	93^0 40'W	1978-1992
6022300	EMO	48^0 38'N	93^0 48'W	1922-1968
6022301	EMO 2	48^0 45'N	93^0 53'W	1957-1968
602B300	EMO HOSKINS	48^0 45'N	93^0 51'W	1978-1993
602K300	EMO RADBOURNE	48^0 41'N	93^0 50'W	1978-1997
6022475	FORT FRANCES	48^0 37'N	93^0 25'W	1892-1995
6022476	FORT FRANCES A	48^0 39'N	93^0 26'W	1976-1997
6022480	FORT FRANCES CDA EPF	48^0 33'N	93^0 31'W	1960-1962
6022487	FORT FRANCES FORESTRY	48^0 37'N	93^0 24'W	1943-1965
6024010	KAWENE	48^0 44'N	91^0 12'W	1935-1951
6025203	MINE CENTRE	48^0 46'N	92^0 37'W	1914-1997
6025407	MOOSE LAKE	48^0 50'N	91^0 36'W	1950-1972
6026852	RAINY RIVER	48^0 43'N	94^0 32'W	1914-1997
6026853	RAINY RIVER	48^0 46'N	94^0 40'W	1978-1980
602FQ5L	RAINY RIVER-COOPER	48^0 44'N	94^0 37'W	1991-1993
6027825	SLEEMAN	48^0 43'N	94^0 25'W	1964-1991
6028125	STRATTON	48^0 47'N	94^0 3'W	1970-1986
6028127	STRATTON ROEN	48^0 51'N	94^0 1'W	1978-1983
6028128	STRATTON ROMYN	48^0 42'N	94^0 10'W	1978-1997

Kenora District

6030488	BARCLAY	49^0 50'N	92^0 49'W	1885-1896
6032117	DRYDEN	49^0 47'N	92^0 50'W	1914-1997
6032119	DRYDEN A	49^0 50'N	92^0 45'W	1970-1997
6032122	DRYDEN FORESTRY	49^0 49'N	92^0 51'W	1960-1968
6032192	EAGLE RIVER	49^0 49'N	93^0 13'W	1986-1988
6033690	IGNACE	49^0 25'N	91^0 9'W	1889-1971
6033697	IGNACE TCPL 58	49^0 29'N	92^0 0'W	1969-1993
6033785	INGOLF	49^0 49'N	95^0 9'W	1927-1941

6034070	KENORA	49° 48'N	94° 32'W	1883-1939
6034075	KENORA A	49° 47'N	94° 22'W	1938-1997
6034077	KENORA TCPL 49	49° 47'N	94° 29'W	1969-1991
6034282	LAC SEUL	50° 17'N	92° 12'W	1914-1941
6035000	MARTIN	49° 15'N	91° 8'W	1957-1962
6035002	MARTIN TCPL 60	49° 17'N	91° 14'W	1969-1984
6035190	MINAKI	49° 59'N	94° 40'W	1930-1967
6036904	RAWSON LAKE	49° 39'N	93° 43'W	1969-1997
6037770	SIOUX LOOKOUT	50° 8'N	91° 52'W	1930-1938
6037768	SIOUX LOOKOUT	50° 8'N	91° 52'W	1914-1932
6037775	SIOUX LOOKOUT A	50° 7'N	91° 54'W	1938-1997
6037804	SIOUX NARROWS	49° 23'N	94° 4'W	1980
6037803	SIOUX NARROWS	49° 29'N	93° 58'W	1933-1956
6039130	VALORA	49° 45'N	91° 13'W	1957-1959
6039136	VERMILION BAY TCPL 52	49° 50'N	93° 38'W	1969-1984
6039351	WATCOMB	49° 54'N	91° 17'W	1969-1977
6039465	WHITEFISH BAY	49° 29'N	93° 58'W	1914-1946

Thunder Bay District

6040011	ABITIBI CAMP 11	48° 51'N	89° 7' W	1983-1988
6040010	ABITIBI CAMP 11	48° 56'N	89° 21'W	1978-1983
6040018	ABITIBI CAMP 228	48° 56'N	89° 15'W	1969-1978
6040020	ABITIBI CAMP 230	49° 21'N	89° 22'W	1969-1991
6040022	ABITIBI CAMP 300	49° 38'N	89° 45'W	1978-1986
6040081	AGUASABON	48° 47'N	87° 10'W	1950-1972
6040322	ARMSTRONG	50° 17'N	89° 9'W	1926-1947
6040326	ARMSTRONG (AUT)	50° 18'N	89° 2'W	1994-1995
6040325	ARMSTRONG A AUT	50° 17'N	88° 55'W	1938-1997
6040330	ARMSTRONG JELLIEN	50° 15'N	89° 6'W	1987-1992
6040572	BEARDMORE	49° 37'N	87° 57'W	1973-1986
6040785	BLACK STURGEON LAKE	49° 19'N	88° 51'W	1951-1968
6040786	BLACK STURGEON LAKE 2	49° 18'N	88° 48'W	1968-1971
6040790	BLACK STURGEON RIVER	49° 4'N	88° 37'W	1957-1959
6041036	BURCHELL LAKE	48° 37'N	90° 35'W	1962-1967
6041109	CAMERON FALLS	49° 9'N	88° 21'w	1924-1997
6041193	CARAMAT	49° 16'N	85° 50'W	1949-1983
6041221	CARIBOU ISLAND	47° 20'N	85° 50'W	1935-1988
6041222	CARIBOU ISLAND (AUT)	47° 20'N	85° 50'W	1993-1997
6042036	DOG LAKE DAM	48° 42'N	89° 37'W	1923-1958
6042045	DOG RIVER	48° 59'N	89° 54'W	1957-1960
6042063	DONA	48° 30'N	89° 31'W	1926-1958
6042067	DORION TCPL 70	48° 49'N	88° 31'W	1969-1984
6042MJ7	FLINT	48° 21'N	89° 41'W	1979-1997
6042715	GERALDTON	49° 42'N	86° 57'W	1967-1981
6042716	GERALDTON A	49° 47'N	86° 56'W	1981-1997
6042723	GERALDTON FORESTRY	49° 42'N	86° 52'W	1948-1969
6042755	GERALDTON ONT HYDRO	49° 41'N	86° 57'W	1950-1973
6042975	GRAHAM A	49° 16'N	90° 35'W	1948-1967
6043330	HANOVER TOWER	50° 24'N	87° 10'W	1952-1955
6043452	HEMLO GOLD	48° 42'N	85° 53'W	1985-1997
6043458	HERON BAY	48° 40'N	86° 17'W	1886-1920
6043460	HERON BAY SOUTH	48° 59'N	85° 49'W	1954
6043870	JARVIS LAKE	49° 15'N	87° 49'W	1952-1956
6043930	KAKABEKA FALLS	48° 24'N	89° 37'W	1908-1977
6043949	KAMINISTIKWIA	48° 33'N	89° 24'W	1973-1974
6044000	KASHABOWIE	48° 36'N	90° 36'W	1956-1958
604M002	KATATOTA ISLAND	49° 43'N	88° 20'W	1996-1997
6044050	KENOGAMI DAM	49° 55'N	86° 28'W	1950-1958
6044115	KILLALA LAKE	49° 9'N	86° 28'W	1945-1954
6044138	KINGFISHER LAKE	48° 39'N	89° 4'W	1975-1977
6044298	LAKEHEAD UNIVERSITY	48° 26'N	89° 16'W	1968-1997
6044595	LONG LAKE CONTROL DAM	49° 5'N	87° 3'W	1950-1964
6044525	LONGLAC	49° 45'N	86° 30'W	1921-1957
6044560	LONGLAC P AND P	49° 46'N	86° 32'W	1951-1969
6044612	LOON	48° 38'N	88° 46'W	1979-1980
6044735	MACDIARMID	49° 26'N	88° 9'W	1926-1970

6044890	MANITOU FALLS	49° 12'N	86° 6'W	1948-1955
6044903	MANITOUWADGE	49° 9'N	85° 48'W	1956-1995
6044959	MARATHON	48° 43'N	86° 24'W	1945-1984
6044961	MARATHON A	48° 45'N	86° 20'W	1988-1997
6045541	MYRT LAKE	48° 28'N	90° 43'W	1980-1985
6045550	NAKINA A	50° 11'N	86° 42'W	1939-1967
6045572	NAKINA FORESTRY	50° 11'N	86° 42'W	1929-1959
6045665	NIPIGON	49° 0'N	88° 15'W	1886-1922
6045675	NOLALU	48° 9'N	89° 53'W	1973-1980
6045676	NOLALU SSW22	48° 6'N	89° 53'W	1979-1985
6045711	NORTH LAKE	48° 8'N	90° 34'W	1921-1941
6045781	ONE ISLAND LAKE	48° 39'N	89° 25'W	1992-1993
6046164	OXALINE LAKE	49° 42'N	87° 34'W	1952-1956
6046281	PAYS PLAT	48° 52'N	87° 36'W	1952-1965
6046283	PAYS PLAT FORESTRY	48° 53'N	87° 32'W	1944-1950
604FNL6	PIGEON RIVER	48° 5'N	89° 38'W	1970-1978
6046549	PINE PORTAGE	49° 18'N	88° 19'W	1950-1968
6046588	PORT ARTHUR	48° 26'N	89° 13'W	1877-1941
6046590	PORT ARTHUR CKPR	48° 25'N	89° 16'W	1959-1963
6046767	PUKASKWA	48° 35'N	86° 18'W	1996-1997
6046770	PUKASKWA NATL PARK	48° 36'N	86° 18'W	1983-1997
6046811	QUORN	49° 25'N	90° 54'W	1915-1960
6046856	RAITH TCPL 64	48° 44'N	89° 52'W	1969-1984
6046989	REDMOND	50° 14'N	87° 30'W	1952-1956
6047615	SAVANNE	48° 58'N	90° 12'W	1884-1954
6047617	SAVANNE LAKE	48° 50'N	90° 6'W	1969
6047620	SAVANT LAKE	50° 28'N	90° 21'W	1930-1944
6047627	SCHREIBER	48° 49'N	87° 16'W	1893-1975
6047810	SLATE ISLAND	48° 37'N	86° 59'W	1966-1989
6048017	STEVENS	49° 32'N	85° 51'W	1945-1955
6048145	STURGEON LAKE	49° 53'N	90° 58'W	1972-1994
6048175	SUMMIT CONTROL DAM	50° 38'N	88° 12'W	1950-1959
6048230	TERRACE BAY	48° 48'N	87° 6'W	1972-1997
6048231	TERRACE BAY A	48° 49'N	87° 6'W	1996-1997
6048261	THUNDER BAY A	48° 22'N	89° 19'W	1941-1997
6048K6J	THUNDER BAY MCS CENTRE	48° 19'N	89° 23'W	1980-1984
604H26A	THUNDER BAY POMBER	48° 30'N	89° 13'W	1979-1988
604HK61	THUNDER BAY PROVINCIAL P	48° 27'N	89° 10'W	1990
604HBFA	THUNDER BAY WPCP	48° 24'N	89° 14'W	1960-1989
604S003	THUNDERBAY A FIREHALL	48° 22'N	89° 19'W	1995-1996
6048864	TRANQUILLO RIDGE	48° 14'N	89° 31'W	1991-1997
6048951	TROUT LAKE	48° 37'N	89° 22'W	1980-1981
6048955	TROWBRIDGE (AUT)	48° 18'N	89° 52'W	1993-1997
6049096	UPSALA	49° 3'N	90° 28'W	1947-1972
6049095	UPSALA (AUT)	49° 2'N	90° 28'W	1973-1997
6049098	UPSALA TCPL 62	49° 2'N	90° 31'W	1970-1986
6049175	WABOOSE DAM	50° 47'N	87° 59'W	1941-1956
6049443	WELCOME ISLAND	48° 22'N	89° 7'W	1967-1997
6049466	WHITEFISH LAKE	48° 17'N	89° 55'W	1980-1997

Algoma District

6050NNP	BAR RIVER	46° 26'N	84° 3'W	1988-1992
6050801	BLIND RIVER	46° 12'N	83° 0'W	1926-1959
6050805	BLIND RIVER HYDRO CENTRE	46° 12'N	83° 1'W	1982-1989
6051027	BRUCE MINES	46° 18'N	83° 55'W	1898-1914
605102G	BRUCE MINES RADIGAN	46° 18'N	83° 45'W	1978-1980
6051R65	DALTON	48° 9'N	84° 2'W	1977-1979
6052258	ELLIOT LAKE	46° 23'N	82° 39'W	1959-1973
6052259	ELLIOT LAKE A	46° 21'N	82° 34'W	1995-1997
6052260	ELLIOT LAKE DENISON	46° 30'N	82° 37'W	1974-1980
6052268	ELLIOT LAKE STANLEIGH	46° 25'N	82° 39'W	1984-1997
6052563	FRANZ	48° 28'N	84° 25'W	1917-1960
6053391	HAWK JUNCTION	48° 5'N	84° 33'W	1969-1971
6053463	HIGH FALLS	47° 55'N	84° 43'W	1976-1989
6053570	HORNEPAYNE	49° 14'N	84° 48'W	1917-1989
6053575	HORNEPAYNE A	49° 12'N	84° 46'W	1990-1995

6053804	IRON BRIDGE	46° 17'N	83° 14'W	1974-1975
6053803	IRON BRIDGE	46° 16'N	83° 21'W	1988-1991
6054078	KENTVALE	46° 13'N	84° 4'W	1988
605DJ25	KILLARNEY (AUT)	45° 58'N	81° 29'W	1993-1997
6055095	MICHIPICOTEN FALLS	47° 53'N	84° 38'W	1882-1928
6055209	MISSANABIE	48° 19'N	84° 5'W	1889-1902
6055210	MISSISSAGI ONT HYDRO	46° 26'N	83° 23'W	1970-1997
6055302	MONTREAL FALLS	47° 16'N	84° 26'W	1976-1997
6055300	MONTREAL FALLS	47° 15'N	84° 24'W	1932-1955
6055754	OBA	49! 4'N	84° 6'W	1926-1946
6056389	PESHU LAKE	46° 37'N	83° 10'W	1950-1955
6056907	RAYNER	46° 20'N	83° 30'W	1950-1970
6057437	SAND LAKE	47° 47'N	84° 32'W	1954-1956
6057595	SAULT STE M FORESTRY	46° 30'N	84° 22'W	1889-1933
6057597	SAULT STE M INSECTARY	46° 28'N	84° 28'W	1951-1954
6057605	SAULT STE M SHINGWOUK	46° 30'N	84° 17'W	1954-1955
6057589	SAULT STE MARIE	46° 32'N	84° 30'W	1949-1959
6057590	SAULT STE MARIE 2	46° 32'N	84° 20'W	1957-1997
6057592	SAULT STE MARIE A	46° 29'N	84° 30'W	1945-1997
6057678	SEARCHMONT	46° 45'N	84° 5'W	1915-1975
6057327	ST JOSEPH ISLAND MTN	46° 12'N	83° 57'W	1970-1971
6058010	STEEP HILL FALLS	48° 4'N	84° 48'W	1915-1939
6059211	WALFORD	46° 12'N	82° 17'W	1979
6059210	WALFORD	46° 12'N	82° 14'W	1976-1979
6059409	WAWA	48° 0'N	84° 48'W	1969-1984
6059408	WAWA	47° 58'N	84° 47'W	1940-1967
6059D09	WAWA A	47° 58'N	84° 47'W	1977-1997
6059475	WHITE RIVER	48° 36'N	85° 17'W	1886-1976

Sudbury District

6060070	AGNEW MINE	46° 26'N	81° 37'W	1978-1983
6060725	BENNY	46° 31'N	81° 38'W	1948-1956
6060773	BISCOTASING	47!18' N	82° 6'W	1914-1997
6061263	CARTIER	46° 42'N	81° 34'W	1886-1948
6061358	CHAPLEAU	47° 50'N	83° 26'W	1965-1976
6061359	CHAPLEAU 2	47° 50'N	83° 26'W	1886-1966
6061361	CHAPLEAU A	47° 49'N	83° 21'W	1978-1997
6061847	CONISTON	46° 28'N	80° 49'W	1921-1976
6061850	CONISTON STP	46° 29'N	80° 51'W	1962-1997
6061870	COPPER CLIFF	46° 29'N	81° 3'W	1906-1968
6062425	FOLEYET	48° 15'N	82° 26'W	1931-1974
6062665	GARSON	46° 34'N	80° 52'W	1962-1965
6062860	GOGAMA TREE NURSERY	47° 41'N	81° 43'W	1989-1992
6064460	LIVELY	46° 26'N	81° 9'W	1981-1991
6064942	MANVILLE REEVES	48° 13'N	82° 25'W	1973-1975
6065006	MASSEY	46° 11'N	82° 1'W	1983-1997
6065005	MASSEY	46° 13'N	82° 4'W	1963-1964
6065015	MATTAGAMI LAKE DAM	48° 1'N	81° 33'W	1950-1957
6065020	MATTAGAMI PATROL	47° 54'N	81° 33'W	1957-1961
6065043	MCVITTIES	46° 17'N	80° 51'W	1950-1974
6065250	MONETVILLE	46° 9'N	80° 18'W	1963-1997
6066873	RAMSAY	47° 27'N	82° 20'W	1973-1983
6066877	RAMSEY 2	47° 28'N	81° 52'W	1984-1986
6067211	RUEL	47° 18'N	81° 27'W	1915-1959
6067308	ST CHARLES	46° 22'N	80° 31'W	1979-1984
6068148	SUDBURY	46° 29'N	80° 59'W	1887-1977
6068150	SUDBURY A	46° 37'N	80° 48'W	1954-1997
6068155	SUDBURY MOE	46° 28'N	81° 2'W	1977-1979
6068158	SUDBURY SCIENCE NORTH	46° 28'N	81° 0'W	1986-1996
6068980	TURBINE	46° 23'N	81° 34'W	1914-1990
6069165	WABAGISHIK	46° 19'N	81° 31'W	1978-1989
6069197	WAHNAPITAE-STOKES	46° 26'N	80° 43'W	1990-1991

Timiskaming District

6070027	ABITIBI CANYON	49^0 53'N	81^0 34'W	1931-1963
6070QK6	BONNER LAKE	49^0 23'N	82^0 7'W	1990-1997
6071712	COCHRANE	49^0 4'N	81^0 2'W	1910-1993
6071855	CONNAUGHT	48^0 37'N	80^0 55'W	1962-1981
6072183	DYMOND ONT HYDRO	47^0 31'N	79^0 41'W	1973-1997
6072225	EARLTON A	47^0 42'N	79^0 51'W	1938-1997
6072325	ENGLEHART	47^0 49'N	79^0 54'W	1948-1997
6072460	FORT ALBANY	52^0!13'N	81^0 40'W	1968-1993
6072595	FREDERICKHOUSE LAKE DAM	48^0 46'N	80^0 59'W	1950-1961
6073138	HAILEYBURY	47^0 27'N	79^0 38'W	1893-1977
6073420	HEASLIP	47^0 48'N	79^0 50'W	1928-1967
6073600	HOUND CHUTE	47^0 18'N	79^0 42'W	1950-1969
6073630	HUNTA	49^0 7'N	81^0 16'W	1950-1973
6073750	INDIAN CHUTE	47^0 51'N	80^0 27'W	1950-1972
6073810	IROQUOIS FALLS	48^0 45'N	80^0 40'W	1913-1997
6073840	ISLAND FALLS	49^0 35'N	81^0 23'W	1955-1996
6073975	KAPUSKASING A	49^0 25'N	82^0 28'W	1937-1997
6073960	KAPUSKASING CDA	49^0 24'N	82^0 26'W	1918-1997
6074100	KIDD CREEK MINE	48^0 41'N	81^0 22'W	1968-1979
6074209	KIRKLAND LAKE	48^0 9'N	80^0 0'W	1950-1996
6074620	LOWBUSH	48^0 55'N	80^0 7'W	1951-1966
6074630	LOWER STURGEON	48^0 49'N	81^0 29'W	1950-1967
6075012	MATHESON	48^0 32'N	80^0 27'W	1968-1972
6075013	MATHESON ONT HYDRO	48^0 32'N	80^0 28'W	1983-1992
6075024	MATTICE TCPL	49^0 36'N	83^0 10'W	1966-1995
6075211	MISTINIKON LAKE DAM	48^0 3'N	80^0 43'W	1950-1960
6075379	MONTREAL RIVER	47^0 7'N	79^0 29'W	1910-1967
6075400	MOOSE FACTORY	51^0 14'N	80^0 30'W	1877-1938
6075425	MOOSONEE	51^0 16'N	80^0 39'W	1932-1997
6075428	MOOSONEE A	51^0 17'N	80^0 36'W	1995-1997
6075542	NAGAGAMI	49^0 46'N	84^0 31'W	1964-1969
6075543	NAGAGAMI (AUT)	49^0 45'N	84^0 10'W	1993-1997
6075594	NEW LISKEARD	47^0 30'N	79^0 40'W	1923-1984
6076180	PAGWA	50^0 3'N	85^0 18'W	1918-1934
6076200	PAGWA A	50^0 2'N	85^0 16'W	1938-1964
6076540	PINARD	49^0 51'N	81^0 36'W	1963-1982
6076572	PORCUPINE ONT HYDRO	48^0 28'N	81^0 16'W	1969-1997
6076575	PORQUIS JUNCTION A	48^0 44'N	80^0 48'W	1938-1955
6076870	RAMORE TS	48^0 20'N	80^0 26'W	1960-1966
6077475	SANDY FALLS	48^0 31'N	81^0 26'W	1950-1964
6077845	SMOKY FALLS	50^0 4'N	82^0 10'W	1933-1997
6078280	TIMMINS	48^0 30'N	81^0 20'W	1922-1957
6078285	TIMMINS A	48^0 34'N	81^0 22'W	1955-1997
6078290	TIMMINS ONT HYDRO	48^0 28'N	81^0 22'W	1951-1969
6079040	TWIN FALLS	48^0 45'N	80^0 35'W	1955-1973
6079068	UPPER NOTCH	47^0 15'N	79^0 35'W	1950-1971
6079415	WAWAITIN	48^0 21'N	81^0 24'W	1913-1965

Nipissing District

6080189	ALGONQUIN PARK	45^0 35'N	78^0 33'W	1917-1960
6080191	ALGONQUIN PARK EAST	45^0 32'N	78^0 16'W	1961-1972
6080193	ALGONQUIN PARK WEST	45^0 20'N	78^0 51'W	1961-1972
6080577	BEAR ISLAND	46^0 59'N	80^0 5'W	1916-1962
6080729	BIG CHAUDIERE FALLS	46^0 9'N	80^0 1'W	1918-1933
6080HB6	BONFIELD	46^0 13'N	79^0 8'W	1983-1992
608A06G	CACHE BAY	46^0 23'N	80^0 1'W	1981-1985
6081928	CRYSTAL FALLS	46^0 27'N	79^0 52'W	1922-1988
6082178	DWIGHT	45^0 23'N	78^0 54'W	1973-1997
6082612	FRENCH R CHAUDIERE DAM	46^0 8'N	80^0 1'W	1969-1997
6084278	LA CAVE	46^0 22'N	78^0 44'W	1950-1975
6084300	LAKE OPEONGO	45^0 38'N	78^0 22'W	1962-1989
6084307	LAKE TRAVERSE	45^0 57'N	78^0 4'W	1965-1987
6084770	MADAWASKA	45^0 30'N	77^0 59'W	1915-1997

6085023	MATTAWA	46^0 15'N	78^0 41'W	1882-1899
6085682	NORTH BAY	46^0 19'N	79^0 28'W	1887-1982
6085700	NORTH BAY A	46^0 21'N	79^0 26'W	1939-1997
6085703	NORTH BAY NIPISSING(AUT)	46^0 9'N	79^0 29'W	1994-1997
6085704	NORTH BAY OWRC	46^0 18'N	79^0 28'W	1960-1971
6086930	RED CEDAR LAKE DAM	46^0 41'N	80^0 1'W	1950-1954
6087255	RUTHERGLEN	46^0 15'N	79^0 4'W	1891-1940
6088144	STURGEON FALLS	46^0 22'N	79^0 56'W	1883-1997
6088271	TIMAGAMI	47^0 5'N	79^0 51'W	1966-1973

Manitoulin Island District

6091718	COCKBURN ISLAND	45^0 57'N	83^0 18' W	1897-1910
6092915	GORE BAY	45^0 55'N	82^0 28' W	1881-1983
6092925	GORE BAY A	45^0 53'N	82^0 34' W	1947-1997
6093004	GREAT DUCK ISLAND	45^0 39'N	82^0 58' W	1966-1985
6093005	GREAT DUCK ISLAND (AUT)	45^0 38'N	82^0 58' W	1993-1997
6093900	KAGAWONG	45^0 55'N	82^0 16' W	1951-1961
6094450	LITTLE CURRENT	45^0 56'N	81^0 54' W	1871-1895
6094449	LITTLE CURRENT	45^0 58'N	81^0 55' W	1986-1989
6096755	PROVIDENCE BAY	45^0 40'N	82^0 14' W	1897-1940
6097915	SOUTH BAYMOUTH	45^0 35'N	82^0 1' W	1954-1993

APPENDIX III

STREAMFLOW STATIONS IN NORTHERN ONTARIO

STATION ID	STATION NAME
02AA001	PIGEON RIVER AT MIDDLE FALLS
02AA002	PINE RIVER NEAR CROOKS
02AB001	KAMINISTIQUIA RIVER NEAR DONA
02AB002	SHEBANDOWAN RIVER NEAR KAMINISTIQUIA
02AB003	KAMINISTIQUIA RIVER AT MOKOMON
02AB004	KAMINISTIQUIA RIVER AT OUTLET OF DOG LAKE
02AB005	SHEBANDOWAN RIVER AT GLENWATER
02AB006	KAMINISTIQUIA RIVER AT KAMINISTIQUIA
02AB007	KAMINISTIQUIA RIVER AT STANLEY
02AB008	NEEBING RIVER NEAR THUNDER BAY
02AB009	SHEBANDOWAN RIVER AT SUNSHINE
02AB010	KAMINISTIQUIA RIVER AT KAKABEKA FALLS POWERHOUSE
02AB011	SHEBANDOWAN RIVER AT OUTLET OF SHEBANDOWAN LAKE
02AB012	GREENWATER CREEK AT OUTLET OF GREENWATER LAKE
02AB013	KASHABOWIE RIVER AT OUTLET OF KASHABOWIE LAKE
02AB014	NORTH CURRENT RIVER NEAR THUNDER BAY
02AB015	CURRENT RIVER NEAR STEPSTONE
02AB016	MCINTYRE RIVER AT THUNDER BAY
02AB017	WHITEFISH RIVER AT NOLALU
02AB018	LAKE SUPERIOR AT THUNDER BAY
02AB019	MCVICAR CREEK AT THUNDER BAY
02AB020	MCINTYRE RIVER ABOVE THUNDER BAY
02AB021	CURRENT RIVER AT STEPSTONE
02AC001	WOLF RIVER AT HIGHWAY NO. 17
02AC002	BLACK STURGEON RIVER AT HIGHWAY NO. 17
02AD002	NIPIGON RIVER NEAR CAMERON FALLS
02AD003	LAKE NIPIGON AT ORIENT BAY
02AD006	NIPIGON RIVER BELOW VIRGIN FALLS
02AD007	LAKE NIPIGON AT MACDIARMID
02AD008	NIPIGON RIVER AT PINE PORTAGE
02AD009	OGOKI RIVER DIVERSION TO LAKE NIPIGON
02AD010	BLACKWATER RIVER AT BEARDMORE
02AD011	NAMEWAMINIKAN RIVER AT LONG RAPIDS
02AE001	GRAVEL RIVER NEAR CAVERS
02BA002	STEEL RIVER NEAR TERRACE BAY
02BA003	LITTLE PIC RIVER NEAR COLDWELL
02BA004	LAKE SUPERIOR AT ROSSPORT
02BA005	WHITESAND RIVER ABOVE SCHREIBER AT MINOVA MINE
02BB002	BLACK RIVER NEAR MARATHON
02BB003	PIC RIVER NEAR MARATHON
02BB004	CEDAR CREEK NEAR HEMLO
02BC002	WHITE RIVER AT BERTRAND
02BC003	WHITE RIVER AT REGAN
02BC004	WHITE RIVER BELOW WHITE LAKE
02BC005	PUKASKWA RIVER AT PUKASKWA NATIONAL PARK
02BD001	MAGPIE RIVER AT STEEP HILL FALLS
02BD002	MICHIPICOTEN RIVER AT HIGH FALLS
02BD003	MAGPIE RIVER NEAR MICHIPICOTEN
02BD004	LAKE SUPERIOR AT MICHIPICOTEN HARBOUR
02BD005	MAGPIE RIVER AT ESNAGI LAKE
02BD006	WAWA CREEK AT WAWA
02BE001	MONTREAL RIVER AT ALGOMA CENTRAL AND HUDSON BAY RAILWAY
02BE002	MONTREAL RIVER NEAR MONTREAL RIVER HARBOUR
02BF001	BATCHAWANA RIVER NEAR BATCHAWANA
02BF002	GOULAIS RIVER NEAR SEARCHMONT

02BF003	BENNET CREEK AT SAULT STE. MARIE
02BF004	BIG CARP RIVER NEAR SAULT STE. MARIE
02BF005	NORBERG CREEK (SITE A) ABOVE BATCHAWANA RIVER
02BF006	NORBERG CREEK (SITE B) AT OUTLET OF TURKEY LAKE
02BF007	NORBERG CREEK (SITE C) AT OUTLET OF LITTLE TURKEY LAKE
02BF008	NORBERG CREEK (SITE D) BELOW WISHART LAKE
02BF009	NORBERG CREEK (SITE E) BELOW BATCHAWANA LAKE
02BF010	LAKE SUPERIOR AT GROS CAP
02BF011	ST. MARYS RIVER AT SAULT STE. MARIE (ABOVE)
02BF012	NORBERG CREEK (SITE F) AT OUTLET OF BATCHAWANA LAKE
02BF013	TRIBUTARY TO NORBERG CREEK AT TURKEY LAKE
02CA001	ST. MARYS RIVER AT SAULT STE. MARIE
02CA002	ROOT RIVER AT SAULT STE. MARIE
02CA003	ST. MARYS RIVER NEAR GARDEN RIVER
02CA004	ST. MARYS RIVER ABOVE CLARK CREEK
02CA005	ST. MARYS RIVER AT SAULT STE. MARIE (BELOW)
02CA006	LAKE HURON AT THESSALON
02CB001	MISSISSAGI RIVER BELOW AUBREY FALLS
02CB002	MISSISSAGI RIVER AT ROCKY ISLAND LAKE
02CB003	AUBINADONG RIVER ABOVE SESABIC CREEK
02CC002	MISSISSAGI RIVER AT IRON BRIDGE
02CC003	MISSISSAGI RIVER BELOW IRON BRIDGE
02CC004	MISSISSAGI RIVER AT MISSISSAGI
02CC005	LITTLE WHITE RIVER NEAR BELLINGHAM
02CC006	MISSISSAGI RIVER NEAR WHARNCLIFFE
02CC007	MISSISSAGI RIVER AT RAYNER GENERATING STATION
02CC008	MISSISSAGI RIVER AT MISSISSAGI CHUTE
02CC009	MISSISSAGI RIVER AT RED ROCK FALLS
02CC010	LITTLE WHITE RIVER BELOW BOLAND RIVER
02CD001	SERPENT RIVER AT HIGHWAY NO. 17
02CD002	SERPENT RIVER AT OUTLET OF DUNLOP LAKE
02CD003	SERPENT RIVER BELOW QUIRKE LAKE
02CD004	SERPENT RIVER BELOW PECORS LAKE
02CD005	ROCHESTER CREEK ABOVE QUIRKE LAKE
02CD006	SERPENT RIVER ABOVE QUIRKE LAKE
02CD007	LITTLE NORDIC CREEK AT ELLIOT LAKE
02CD008	NORDIC MINE TAILINGS DITCH (SITE 1) NEAR ELLIOT LAKE
02CD009	NORDIC MINE TAILINGS DITCH (SITE 2) NEAR ELLIOT LAKE
02CD010	NORDIC MINE TAILINGS DITCH (SITE 3) NEAR ELLIOT LAKE
02CE001	SPANISH RIVER AT ESPANOLA
02CE002	AUX SABLES RIVER AT MASSEY
02CE003	SPANISH RIVER AT WEBBWOOD
02CE004	SPANISH RIVER AT HIGH FALLS
02CE103	MINISTIC CREEK NEAR AGNEW LAKE MINE
02CF001	VERMILION RIVER NEAR WHITEFISH
02CF002	VERMILION RIVER BELOW KUSK LAKE
02CF004	VERMILION RIVER AT LORNE FALLS
02CF005	JUNCTION CREEK AT SUDBURY
02CF007	WHITSON RIVER AT CHELMSFORD
02CF008	WHITSON RIVER AT VAL CARON
02CF009	NOLIN CREEK AT SUDBURY
02CF010	ONAPING RIVER NEAR LEVACK
02CF011	VERMILION RIVER NEAR VAL CARON
02CF012	JUNCTION CREEK BELOW KELLEY LAKE
02CF013	MOOSE CREEK AT LEVACK
02CF100	VERMILION RIVER NEAR CAPREOL
02CG001	KAGAWONG RIVER AT KAGAWONG
02CG002	LAKE HURON AT LITTLE CURRENT
02CG003	BLUE JAY CREEK NEAR TEHKUMMAH

02DA001	WANAPITEI RIVER AT OUTLET OF WANAPITEI LAKE
02DA002	WANAPITEI LAKE AT BOWLANDS BAY
02DB001	WANAPITEI RIVER NEAR WANAPITEI
02DB002	WANAPITEI RIVER AT MCVITTIES
02DB003	WANAPITEI RIVER NEAR CONISTON
02DB004	CONISTON CREEK NEAR CONISTON
02DB005	WANAPITEI RIVER NEAR WANUP
02DB006	WANAPETEI RIVER NEAR STINSON
02DB007	CONISTON CREEK ABOVE WANAPITEI RIVER
02DC001	STURGEON RIVER AT SMOKY FALLS
02DC002	STURGEON RIVER BELOW SMOKY FALLS
02DC003	STURGEON RIVER AT CRYSTAL FALLS
02DC004	STURGEON RIVER NEAR GLEN AFTON
02DC005	TEMAGAMI RIVER NEAR RIVER VALLEY
02DC006	TOMIKO RIVER AT OUTLET OF TOMIKO LAKE
02DC007	TEMAGAMI RIVER AT CROSS LAKE DAM
02DC008	TEMAGAMI RIVER AT RED CEDAR LAKE DAM
02DC009	MARTEN RIVER AT WICKSTEED LAKE DAM
02DC010	TEMAGAMI LAKE AT TEMAGAMI
02DC011	STURGEON RIVER AT LOWER GOOSE FALLS
02DC012	STURGEON RIVER AT UPPER GOOSE FALLS
02DD001	SOUTH RIVER NEAR POWASSAN
02DD002	SOUTH RIVER ABOVE TRUISLER CHUTE
02DD004	FRENCH RIVER AT FRENCH RIVER
02DD005	SOUTH RIVER NEAR NIPISSING
02DD006	LAKE NIPISSING AT NORTH BAY
02DD007	FRENCH RIVER AT LAKE NIPISSING
02DD008	DUCHESNAY RIVER NEAR NORTH BAY
02DD009	SOUTH RIVER AT SOUTH RIVER
02DD010	FRENCH RIVER AT DRY PINE BAY
02DD012	VEUVE RIVER NEAR VERNER
02DD013	LA VASE RIVER AT NORTH BAY
02DD014	CHIPPEWA CREEK AT NORTH BAY
02DD015	COMMANDA CREEK NEAR COMMANDA
02DD016	FRENCH RIVER AT PORTAGE DAM
02DD017	FRENCH RIVER AT CHAUDIERE DAM
02DD018	LITTLE FRENCH RIVER AT FREEFLOWING CHANNEL
02DD019	LITTLE FRENCH RIVER AT LITTLE CHAUDIERE DAM
02DD020	LITTLE FRENCH RIVER AT OKIKENDAWT ISLAND
02DD021	LAKE NIPISSING AT FRENCH RIVER OUTLET
02JC008	BLANCHE RIVER ABOVE ENGLEHART
02JD009	MONTREAL RIVER AT MOUNTAIN CHUTES
02JD010	MONTREAL RIVER AT LOWER NOTCH GENERATING STATION
02JD011	LADY EVELYN RIVER AT LADY EVELYN LAKE
02JD012	WEST MONTREAL RIVER AT MISTINIKON LAKE DAM
02JD013	BAY LAKE AT LATCHFORD
02JE011	LAKE TIMISKAMING AT HAILEYBURY
02JE012	OTTAWA RIVER AT LA CAVE RAPIDS
02JE013	OTTAWA RIVER AT MATTAWA
02JE019	AMABLE DU FOND RIVER AT SAMUEL DE CHAMPLAIN PROVIN
02JE020	MATTAWA RIVER BELOW BOUILON LAKE
02JE021	MATABITCHUAN RIVER AT RABBIT LAKE DAM
02JE024	OTTAWA RIVER BELOW TEMISCHAMING
02EA001	SEGUIN RIVER NEAR PARRY SOUND
02EA005	NORTH MAGNETAWAN RIVER NEAR BURK'S FALLS
02EA006	MAGNETAWAN RIVER NEAR BURK'S FALLS
02EA007	MAGNETAWAN RIVER NEAR BYNG INLET
02EA008	MAGNETAWAN RIVER AT MAPLE ISLAND
02EA009	HARRIS CREEK NEAR NAISCOOT
02EA010	NORTH MAGNETAWAN RIVER ABOVE PICKEREL LAKE

02EA011	MAGNETAWAN RIVER NEAR BRITT
02EA012	SHAWANAGA RIVER AT HIGHWAY NO. 69
02EA013	HARRIS RIVER AT HIGHWAY NO. 69
02EA014	LAKE HURON AT PARRY SOUND
04CA001	SANDY LAKE AT SANDY LAKE
04CA002	SEVERN RIVER AT OUTLET OF MUSKRAT DAM LAKE
04CA003	ROSEBERRY RIVER ABOVE ROSEBERRY LAKES
04CA004	SEVERN RIVER BELOW OUTLET OF DEER LAKE
04CB001	WINDIGO RIVER ABOVE MUSKRAT DAM LAKE
04CC001	SEVERN RIVER AT LIMESTONE RAPIDS
04CD001	SACHIGO RIVER BELOW BEAVERSTONE RIVER
04CD002	SACHIGO RIVER BELOW OUTLET OF SACHIGO LAKE
04CE001	BIG TROUT LAKE AT TROUT LAKE
04CE002	FAWN RIVER BELOW BIG TROUT LAKE
04DA001	PIPESTONE RIVER AT KARL LAKE
04DA002	WINISK RIVER AT KANUCHUAN RAPIDS
04DA003	WINISK LAKE AT WEBEQUI
04DA004	WUNNUMMIN LAKE AT WUNNUMMIN LAKE SETTLEMENT
04DB001	ASHEWEIG RIVER AT STRAIGHT LAKE
04DB002	ASHEWEIG RIVER ABOVE LONG DOG LAKE
04DB003	KASABONIKA LAKE AT KASABONIKA
04DC001	WINISK RIVER BELOW ASHEWEIG RIVER TRIBUTARY
04DC002	SHAMATTAWA RIVER AT OUTLET OF SHAMATTAWA LAKE
04EA001	EKWAN RIVER BELOW NORTH WASHAGAMI RIVER
04FA001	OTOSKWIN RIVER BELOW BADESDAWA LAKE
04FA002	KAWINOGANS RIVER NEAR PICKLE CROW
04FA003	PINEIMUTA RIVER AT EYES LAKE
04FB001	ATTAWAPISKAT RIVER BELOW ATTAWAPISKAT LAKE
04FB002	ATTAWAPISKAT LAKE AT LANSDOWNE HOUSE
04FC001	ATTAWAPISKAT RIVER BELOW MUKETEI RIVER
04GA001	LAKE ST. JOSEPH OUTFLOW TO ALBANY RIVER
04GA002	CAT RIVER BELOW WESLEYAN LAKE
04GA003	PASHKOKOGAN RIVER AT OUTLET OF PASHKOKOGAN LAKE
04GA004	LAKE ST. JOSEPH ABOVE RAT RAPIDS DAM
04GB001	OGOKI RIVER AT WABOOSE FALLS DAM
04GB002	WABOOSE LAKE RESERVOIR AT WABOOSE DAM
04GB003	MOJIKIT LAKE RESERVOIR AT MOJIKIT LAKE
04GB004	OGOKI RIVER ABOVE WHITECLAY LAKE
04GB005	BRIGHTSAND RIVER AT MOBERLEY
04GC001	EABAMET LAKE AT FORT HOPE
04GC002	ALBANY RIVER BELOW ACHAPI LAKE
04GD001	ALBANY RIVER ABOVE NOTTIK ISLAND
04GD002	OPICHUAN RIVER AT KELLOW LAKE
04GF001	MUSWABIK RIVER AT OUTLET OF MUSWABIK LAKE
04HA001	ALBANY RIVER NEAR HAT ISLAND
04JA001	KABINAKAGAMI RIVER NEAR KABINA
04JA002	KABINAKAGAMI RIVER AT HIGHWAY NO. 11
04JC001	NAGAGAMI RIVER NEAR AMESON

04JC002	NAGAGAMI RIVER AT HIGHWAY NO. 11
04JC003	SHEKAK RIVER AT HIGHWAY NO. 11
04JD001	LONG LAKE AT LONGLAC
04JD002	KENOGAMI RIVER AT KENOGAMI DAM
04JD003	LONG LAKE DIVERSION TO LAKE SUPERIOR
04JD005	PAGWACHUAN RIVER AT HIGHWAY NO. 11
04JF001	LITTLE CURRENT RIVER AT PERCY LAKE
04JG001	KENOGAMI RIVER NEAR MAMMAMATTAWA
04KA001	KWATABOAHEGAN RIVER NEAR THE MOUTH
04KA002	HALFWAY CREEK AT MOOSONEE
04LA001	MATTAGAMI RIVER AT TIMMINS
04LA002	MATTAGAMI RIVER NEAR TIMMINS
04LB001	MATTAGAMI RIVER AT SMOOTH ROCK FALLS
04LC001	GROUNDHOG RIVER AT HORWOOD LAKE
04LD001	GROUNDHOG RIVER AT FAUQUIER
04LF001	KAPUSKASING RIVER AT KAPUSKASING
04LF903	MATTAGAMI RIVER BELOW ADAMS CREEK
04LG001	MATTAGAMI RIVER AT SMOKY FALLS
04LG002	MOOSE RIVER AT MOOSE RIVER
04LG003	MATTAGAMI RIVER AT LITTLE LONG RAPIDS
04LG004	MOOSE RIVER ABOVE MOOSE RIVER
04LG005	MATTAGAMI RIVER AT ADAM CREEK
04LG901	ADAM CREEK ABOVE MATTAGAMI RIVER
04LG902	MATTAGAMI RIVER ABOVE ADAM CREEK DIVERSION
04LG903	MATTAGAMI RIVER BELOW ADAM CREEK
04LG904	MATTAGAMI RIVER ABOVE GRAND RAPIDS
04LJ001	MISSINAIBI RIVER AT MATTICE
04LK001	MATTAWISHKWIA RIVER AT HEARST
04LM001	MISSINAIBI RIVER BELOW WABOOSE RIVER
04MB003	WATABEAG RIVER AT WATABEAG LAKE DAM
04MC001	ABITIBI RIVER AT IROQUOIS FALLS
04MC002	ABITIBI RIVER AT TWIN FALLS
04MD001	FREDERICK HOUSE RIVER AT FREDERICKHOUSE
04MD002	FREDERICK HOUSE RIVER AT FREDERICK HOUSE LAKE DAM
04MD003	FREDERICK HOUSE RIVER AT NIGHTHAWK LAKE
04MD004	PORCUPINE RIVER AT HOYLE
04ME001	ABITIBI RIVER AT ISLAND FALLS
04ME002	ABITIBI RIVER AT ABITIBI CANYON
04ME003	ABITIBI RIVER AT ONAKAWANA
04ME004	ABITIBI RIVER AT OTTER RAPIDS
04MF001	NORTH FRENCH RIVER NEAR THE MOUTH
05PA001	KETTLE RIVER ABOVE KETTLE FALLS
05PA003	NAMAKAN LAKE ABOVE KETTLE FALLS DAM
05PA004	MALIGNE RIVER, SILVER FALLS, OUTLET SAGANAGA LAKE
05PA005	NORTHERN LIGHT LAKE AT OUTLET
05PA006	NAMAKAN RIVER AT OUTLET OF LAC LA CROIX
05PA007	CROOKED LAKE NEAR CURTAIN FALLS
05PA008	MALIGNE RIVER ABOVE FIRST FALLS

05PA009	PICKEREL RIVER NEAR ATIKOKAN
05PA010	FRENCH LAKE NEAR ATIKOKAN
05PA011	LAC LA CROIX AT CAMPBELL'S CAMP
05PA012	BASSWOOD RIVER NEAR WINTON
05PB001	SEINE RIVER NEAR LA SEINE
05PB002	LITTLE TURTLE LAKE NEAR MINE CENTRE
05PB003	MANITOU RIVER ABOVE DEVIL'S CASCADE
05PB004	FOOTPRINT RIVER AT RAINY LAKE FALLS
05PB007	RAINY LAKE NEAR FORT FRANCES
05PB008	RAINY LAKE BELOW KETTLE FALLS
05PB009	SEINE RIVER AT STURGEON FALLS GENERATING STATION
05PB012	LAC DES MILLE LACS ABOVE OUTLET DAM
05PB014	TURTLE RIVER NEAR MINE CENTRE
05PB015	PIPESTONE RIVER ABOVE RAINY LAKE
05PB018	ATIKOKAN RIVER AT ATIKOKAN
05PB019	NORTHEAST TRIBUTARY TO DASHWA LAKE NEAR ATIKOKAN
05PB020	EASTERN TRIBUTARY TO DASHWA LAKE NEAR ATIKOKAN
05PB021	EYE RIVER NEAR HARDTACK LAKE NORTH OF ATIKOKAN
05PB022	EYE RIVER NEAR COULSON LAKE NORTH OF ATIKOKAN
05PB023	RAINY LAKE AT NORTHWEST BAY
05PB024	RAINY LAKE NEAR BEAR PASS
05PB025	RAINY LAKE AT STOKES BAY
05PC001	RAINY RIVER AT KOOCHICHING FALLS
05PC002	RAINY RIVER AT FORT FRANCES-INTERNATIONAL FALLS POWER PLANT FOREBAY
05PC003	RAINY RIVER AT FORT FRANCES - INTERNATIONAL FALLS POWER PLANT TAILRACE
05PC004	RAINY RIVER AT FORT FRANCES - INTERNATIONAL FALLS POWER MILL FOREBAY
05PC005	RAINY RIVER AT FORT FRANCES - INTERNATIONAL FALLS POWER PLANT CANAL
05PC006	RAINY RIVER AT BOUCHERVILLE
05PC007	RAINY RIVER AT RAINY RIVER
05PC008	RAINY RIVER AT EMO
05PC009	LA VALLEE RIVER AT LA VALLEE
05PC010	STURGEON RIVER NEAR BARWICK
05PC011	PINEWOOD RIVER NEAR PINEWOOD
05PC012	RAINY RIVER AT BIG FORK
05PC013	RAINY RIVER AT LITTLE FORK
05PC014	RAINY RIVER BELOW POWERHOUSE, AT FORT FRANCES
05PC015	RAINY RIVER AT PINEWOOD
05PC016	LA VALLEE RIVER NEAR DEVLIN
05PC017	RAINY RIVER NEAR FORT FRANCES
05PC018	RAINY RIVER AT MANITOU RAPIDS
05PC019	RAINY RIVER AT FORT FRANCES
05PC020	RAINY RIVER AT INTERNATIONAL FALLS
05PC021	RAINY RIVER AT RAINY RIVER
05PD001	LAKE OF THE WOODS AT WARROAD
05PD002	DOG PAW (WHITE FISH) LAKE AT OUTLET
05PD003	LAKE OF THE WOODS AT OAK POINT
05PD005	LAKE OF THE WOODS AT ASH BAY
05PD006	SHOAL LAKE NEAR ASH RAPIDS
05PD007	LOCK LAKE AT ASH RAPIDS
05PD008	LAKE OF THE WOODS AT HANSON BAY
05PD011	LAKE OF THE WOODS AT CLEARWATER BAY
05PD013	LAKE OF THE WOODS AT OAK ISLAND
05PD014	LAKE 114 OUTLET NEAR KENORA
05PD015	LAKE 240 OUTLET NEAR KENORA
05PD016	LAKE 120 OUTLET NEAR KENORA
05PD017	LAKE 470 OUTLET NEAR KENORA
05PD018	LAKE 304 NEAR KENORA
05PD019	LAKE 303 OUTLET NEAR KENORA
05PD020	LAKE 303 NEAR KENORA
05PD021	LAKE 239 NEAR KENORA

05PD022	NORTHWEST TRIBUTARY TO LAKE 239 NEAR KENORA
05PD023	LAKE 239 OUTLET NEAR KENORA
05PD024	LAKE 239, LOWER EAST INLET, NEAR KENORA
05PD025	LAKE 239, UPPER EAST INLET, NEAR KENORA
05PD026	BERRY CREEK AT THE OUTLET OF BERRY LAKE
05PD027	LAKE 114 NEAR KENORA
05PD028	LAKE 661 OUTLET NEAR KENORA
05PD029	LAKE OF THE WOODS AT CYCLONE ISLAND
05PD030	LAKE OF THE WOODS AT SIOUX NARROWS
05PD031	LAKE 239 NORTHEAST INLET NEAR KENORA
05PD032	LAKE 114 INFLOW NEAR KENORA
05PD033	LAKE 979 OUTFLOW NEAR KENORA
05PD034	LAKE 979 NEAR KENORA
05PE001	WINNIPEG RIVER BELOW KENORA POWERHOUSE
05PE003	LAKE OF THE WOODS OUTLET AT BOAT LIFT CHANNEL
05PE004	LAKE OF THE WOODS OUTLET AT MILL 'C' KEEWATIN
05PE005	LAKE OF THE WOODS OUTLET AT MINK CREEK
05PE006	LAKE OF THE WOODS EASTERN OUTLET AT KENORA POWERHOUSE
05PE007	WINNIPEG RIVER AT DALLES RAPIDS
05PE008	WINNIPEG RIVER WEST BRANCH, KEEWATIN RIVER BRIDGE
05PE009	WINNIPEG RIVER AT MINAKI
05PE010	WINNIPEG RIVER AT WHITEDOG FALLS POWERHOUSE
05PE011	LAKE OF THE WOODS WESTERN OUTLET AT NORMAN DAM AND POWERHOUSE
05PE012	WINNIPEG RIVER BELOW NORMAN DAM AND POWERHOUSE
05PE014	LAKE OF THE WOODS AT KEEWATIN
05PE015	WINNIPEG RIVER BELOW MILL A, KEEWATIN
05PE016	LAKE OF THE WOODS AT KENORA
05PE017	WINNIPEG RIVER NEAR OLD FORT ISLAND
05PE018	WINNIPEG RIVER AT THROAT RAPIDS
05PE020	WINNIPEG RIVER BELOW LAKE OF THE WOODS OUTLETS
05PE021	WINNIPEG RIVER AT WHITEDOG INDIAN RESERVE
05PE022	WINNIPEG RIVER ABOVE KIMBERLY RAPIDS
05PE023	WINNIPEG RIVER AT WINNIPEG RIVER MARINA
05PE024	WINNIPEG RIVER NEAR LOCKE BAY
05PE025	WINNIPEG RIVER ABOVE THE DALLES
05PE026	WINNIPEG RIVER ABOVE MYRTLE RAPIDS
05PE027	WINNIPEG RIVER ABOVE THROAT RAPIDS
05PF051	WINNIPEG RIVER ABOVE BOUNDARY FALLS
05QA001	ENGLISH RIVER NEAR SIOUX LOOKOUT
05QA002	ENGLISH RIVER AT UMFREVILLE
05QA003	ENGLISH RIVER ABOVE PELICAN FALLS
05QA004	STURGEON RIVER AT MCDOUGALL MILLS
05QA005	BELL RIVER ABOVE STURGEON LAKE
05QB001	LAC SEUL AT LAC SEUL
05QB002	LAC SEUL AT HUDSON
05QB003	LAC SEUL AT GOLDPINES
05QB004	ENGLISH RIVER BELOW PELICAN FALLS
05QB005	LAKE ST. JOSEPH DIVERSION ABOVE CONTROL DAM
05QB006	LAKE ST. JOSEPH DIVERSION AT ROOT PORTAGE
05QB007	ENGLISH RIVER AT PINE RIDGE
05QC001	CHUKUNI RIVER NEAR EAR FALLS
05QC003	TROUTLAKE RIVER ABOVE BIG FALLS
05QC004	PAKWASH LAKE BELOW SNAKE FALLS
05QD001	WABIGOON RIVER AT WABIGOON FALLS
05QD002	WABIGOON RIVER BELOW RAILWAY BRIDGE, NEAR QUIBELL
05QD003	EAGLE RIVER AT EAGLE RIVER
05QD004	CANYON RIVER AT OUTLET OF FOREST LAKE
05QD006	WABIGOON RIVER NEAR QUIBELL
05QD007	LAKE 305 NEAR KENORA
05QD008	LAKE 227 OUTLET NEAR KENORA

05QD009	LAKE 227 NEAR KENORA
05QD010	WABIGOON RIVER NEAR DRYDEN
05QD011	LAKE 230 OUTLET NEAR KENORA
05QD012	LAKE 261 OUTLET NEAR KENORA
05QD013	LAKE 265 OUTLET NEAR KENORA
05QD015	LAKE 226 OUTLET NEAR KENORA
05QD016	WABIGOON RIVER AT DRYDEN
05QD017	LAKE 223 OUTLET NEAR KENORA
05QD018	LAKE 224 OUTLET NEAR KENORA
05QD019	LAKE 225 OUTLET NEAR KENORA
05QD020	CLAY LAKE NEAR QUIBELL
05QD021	LAKE 223 NEAR KENORA
05QD022	LAKE 302 NEAR KENORA
05QD023	LAKE 302 OUTLET NEAR KENORA
05QD024	LAKE 302 UPLAND WATERSHED NEAR KENORA
05QD025	LAKE 382 OUTFLOW
05QD026	LAKE 373 OUTFLOW NEAR KENORA
05QD027	LAKE 632 OUTFLOW NEAR KENORA
05QD028	LAKE 632 NEAR KENORA
05QE002	ENGLISH RIVER ABOVE MANITOU FALLS
05QE003	ENGLISH RIVER NEAR OAK FALLS
05QE005	ENGLISH RIVER AT CARIBOU FALLS
05QE006	ENGLISH RIVER AT EAR FALLS
05QE007	ENGLISH RIVER AT MANITOU FALLS
05QE008	CEDAR RIVER BELOW WABASKANG LAKE
05QE009	STURGEON RIVER AT OUTLET OF SALVESEN LAKE
05QE011	SALVESEN LAKE NEAR OUTLET
05QE012	LONG-LEGGED RIVER BELOW LONG-LEGGED LAKE
05QE013	BALL LAKE AT BALL LAKE LODGE
05QE014	SEPARATION LAKE AT WALSTENS OUTPOST CAMP
05QE015	GRASSY NARROWS LAKE AT GRASSY NARROWS
05RC001	BERENS RIVER ABOVE BERENS LAKE